IN TWO SECTIONS—SECTION ONE

MECHANICAL ENGINEERING

INCLUDING THE ENGINEERING INDEX

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

IN THIS NUMBER

Location and Distribution of the Central-Station Power of the Middle West
By W. L. Abbott

The Hardness Testing of Metals

Efficiency Tests of a 30,000-Kw. Steam Turbine
By H. B. Reynolds

Two Spring Meeting Papers on the Design of Large Locomotives
By H. W. Snyder and A. F. Stuebing

A.S.M.E. SPRING MEETING ACCOUNT

JULY ·1921

THE MONTHLY JOURNAL PUBLISHED BY THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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Contributors and Contributions

Spring Meeting Papers

A most interesting paper on the Location and Distribution of Central-Station Power in the Middle West, given at the Power Session, appears in this issue of MECHANICAL ENGINEERING. Its author, William L. Abbott, chief operating engineer of the Commonwealth Edison Company of Chicago, presents in this paper a statement of water-power resources of the Middle West and evaluates the coal resources. Mr. Abbott was born in Illinois and was graduated from the University of Illinois in 1884 as a mechanical engineer. His entire career has been associated with the production of electric light and power in Chicago. In 1895 Mr. Abbott was chief engineer of the Harrison Street Station of the Chicago Edison Company, which at that time was the best equipped, if not the largest, power station in the world, having an installed capacity of 6000 kw. in d.c. generators. Since 1899 Mr. Abbott has acted as chief operating engineer of the Commonwealth Edison Company. He has served as trustee of the University of Illinois for sixteen years and for twelve years has acted as president of the Board of Trustees. He is a past-president of the Western Society of Engineers.

WILLIAM L. ABBOTT

The Spring Meeting Railroad Session was devoted to the subject of large freight locomotives. One paper, presented by M. H. Haig, appeared in the May issue of MECHANICAL ENGINEERING; the other two papers on the subject are printed in this issue. H. W. Snyder, the author of the paper entitled The Necessity for Improvement in the Design and Operation of Present-Day Locomotives, was born in Indiana and was graduated from Purdue in 1906. From then until 1916 he worked for the American Locomotive Company in the engineering and calculating departments, and for the last five years of this period was in charge of the calculating department. Since 1916 Mr. Snyder has been assistant to the vice-president, in charge of engineering at the Lima Locomotive Works. A paper showing the advantages of large freight locomotives was presented by Albert F. Stuebing. Mr. Stuebing, a graduate of the University of Illinois, class of 1911, served in various capacities with the Boston and Albany, Pennsylvania, and Rock Island lines until 1917, when he became associated with the Simmons-Boardman Publishing Company as managing editor of *Railway Mechanical Engineer.*

Herbert B. Reynolds' paper on Efficiency Tests of a 30,000-kw. Steam Turbine, presented at the Spring Meeting, describes complete tests of a large power-station unit installed by the Interborough Rapid Transit Company, New York City, at its 59th Street Station. Mr. Reynolds is a graduate of Cornell, 1911, receiving the master's degree in mechanical engineering in 1915. He has been associated with the Westinghouse and General Electric Companies, with the United Electric Railway Company of Baltimore, and the United States Bureau of Mines. For six years he has been engaged by the Interborough Railway Company, and at present is supervising all experimental work and making a study of ways and means of increasing power-plant economy.

This issue of MECHANICAL ENGINEERING carries an account of the most successful Spring Meeting the American Society of Mechanical Engineers has ever held. The attendance was especially large, despite present business conditions and two over-lapping meetings of other societies.

Hardness Report

At the suggestion of Dr. Henry M. Howe, the Engineering Division of the National Research Council appointed a committee to develop a new machine for testing the hardness of metals. In its investigation the Committee conducted a series of tests, the reports of which are summarized as a Progress Report of the Committee on New Hardness Testing Machines. The Progress Report appears in this issue of MECHANICAL ENGINEERING.

This Committee is but one of twenty-eight committees who are conducting research work under the Engineering Division, one of seven technical divisions of the National Research Council. The National Research Council was organized in May 1916 as a measure of national preparedness and the work it accomplished so demonstrated its capacity for larger service that by an executive order issued in May 1918 the President of the United States ordered its perpetuation by the National Academy of Sciences. The chief purpose of the Council is to organize scientific effort, to conserve, collate, initiate, promote and stimulate research and science in its useful application. The American Society of Mechanical Engineers is one of the member societies of the Engineering Division.

The Next Issue

The August issue of MECHANICAL ENGINEERING will complete the presentation of Spring Meeting papers. The important subject of training for the industries, which was given careful consideration at a special session of the Spring Meeting, will have two papers as follows: What the National Metal Trades Association Is Doing and Intends to Do in Industrial Education, by H. C. Smith; and General Education and the Engineering Profession, by H. E. Miles. The papers presented at the Fuel Session by Messrs. Wilson and Tenney will be included, as will the paper on Future Power Development in the Middle West, by C. W. Place, which was given at the Power Session. The Machine Shop Session papers and discussion will also appear in the August issue. The proposed revision of the Constitution and By-Laws of the A.S.M.E. will be included in Section Two of the August issue.

MECHANICAL ENGINEERING

Volume 43 | July, 1921 | Number 7

Location and Distribution of the Central-Station Power of the Middle West

By W. L. ABBOTT,[1] CHICAGO, ILL.

The location and distribution of the central-station power of the Middle West is a subject which has neither the large commercial possibilities of the proposed superpower system of the North Atlantic states nor the spectacular engineering interest of the hydro developments of the Pacific states. The power development of the low, level, rich prairie country, with its wealth of cheap coal, is peculiar to itself, and the distribution is working out its destiny following its natural instincts.

Fig. 1, taken from a recent issue of the *Electrical World*, is an ingenious redistribution of the area of the country, designed to show up the various states in their true electrical importance. This map, which represents relative kilowatt-hour production, is doubtless a fairly accurate representation of installed kilowatt capacity, the total for the United States being given as 12,600,000, of which about one-third, or 4,000,000 kw., is hydroelectric.

Location of the Water Powers of the Middle West

The various potential power streams of the country and the water powers are generally located where they will do the most good—that is, remote from coal mines—the Middle West, in comparison with the rest of the country, not being particularly favored. The states of Ohio, Indiana and Illinois, which are richest in coal, are poorest in water power. Only 18 per cent, or 776,000 kw., of the water power of the country lies in the middle-western states, and the greater part of this is in the states of Michigan, Wisconsin, and Minnesota. Portions of Ohio rise 500 ft. above the Ohio River and above Lake Erie, but the whole state is credited with only 40,000 kw. installed central-station hydroelectric power.

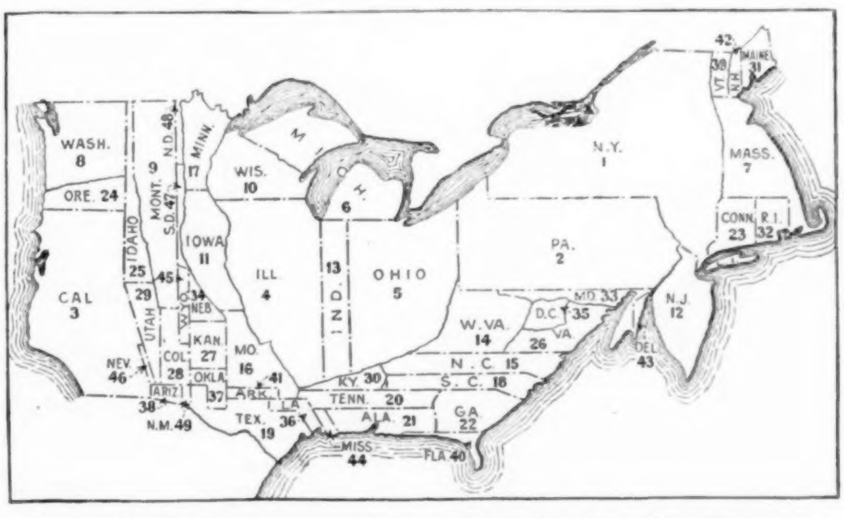

Fig. 1 Relative Sizes of States Based on Their Kilowatt-Hour Production

In Southern Michigan and Northern Indiana is a land elevation of more than 500 ft. above Lake Michigan, giving the St. Joseph River and its tributaries a fall of 10 ft. to the mile over its entire length. The effect of this fall is to dot the map with water powers all along the river's course. A similar elevation near Detroit has its effect on the Huron River, and a hogback up through the center of the southern peninsula makes good mill streams of the Au Sable River, of the Manistee, Grand and Muskegon.

Along the southern shore of Lake Superior the land elevation is, in places, 1000 ft. above the lake, but the territory drained is rather restricted and the rivers are so short that the streams are torrential for a brief interval and almost dry much of the time.

The lower Fox River, between Lake Winnebago and Green Bay, Wis., has a drop of 170 ft. in 28 miles, along which over 40,000 kw. of power was installed long ago and fully occupied by local industries. The level plateau of the watershed of the Fox River and the large pondage of Lake Winnebago make the lower Fox River an ideal one for power. The principal discharge for the rivers of Central Wisconsin is the Mississippi River, which is about 700 ft. above sea level, and as the center of the state abounds in lakes and marshes at elevations of 500 to 1000 ft. above the mouths of the rivers which drain this interior, many important water powers are being developed on these rivers, as at Kilbourn, 6000 kw.; Prairie du Sac, 18,000 kw.; Eau Claire and vicinity, 50,000 kw.; and St. Croix Falls, 18,000 kw.

The principal central-station water power of Minnesota is 50,000 kw. in the vicinity of Duluth. The great water power of the Mississippi River that made Minneapolis famous is principally taken up by flour mills and other local industries. About 33,000 kw. of this power is classified as central-station power.

The territory comprised in this survey includes and extends from Western Pennsylvania to Eastern Kansas, from Southern Kentucky to the Great Lakes and the Canadian border. It comprises an area of 660-000 square miles and a population of 40,000-000. It all lies in the Mississippi Valley and scarcely one per cent can be rated as mountainous, its broad stretches of prairie and forest lands having in general such slight declivity and absorbent soil that the water run-off, excepting that lost in floods, does not exceed one-fifth of the precipitation, and its placid streams for the greater part of their courses flow to the lakes or sea with a slope of half a foot to the mile.

Such a gentle fall of course makes possible relatively little water power, considering the length and breadth of the streams, but as compensation, because these streams have not eroded the soil, the prairie states, with their unrivaled fertility, will some day support a teeming population of hundreds of millions, whose increasing clamor for power must be satisfied principally, as now, by coal drawn from their own great stores.

Water power must be developed at the waterfall , and until long-distance transmission was developed that power had to be used where it was generated; and because much of such power was located in rough, inaccessible country, having no other features of com-

[1] Chief Operating Engineer, Commonwealth Edison Company. Mem. Am.Soc.M.E.

Presented at the Spring Meeting, Chicago, Ill., May 23 to 26, 1921, of The American Society of Mechanical Engineers. All papers are subject to revision.

mercial importance, such rivers were allowed to roll on in solitude "and hear no sound save their own dashing." Now electric transmission has changed all of this, and whereas once factories went to the power, now power goes to the factories, and with a widening effective range of transmission lines and higher cost of coal, more and more of these wild waters are being broken to harness and few of those remaining are escaping serious consideration.

The Question of Power Plants at Mine Mouth

The example of hydroelectric power transmission naturally suggests that coal be burned at the mine to develop steam-electric power for transmission to remote markets, thereby saving the expense and uncertainties of rail shipment. The argument seems plausible, and yet the author is not aware that such a thing is being done anywhere in a large way. Indeed, it is doubtful if in any but the most favorable cases power plants at the mine mouth with a transmission line can successfully compete with power plants located in the remote centers where the power is to be used, the coal necessary for these plants being shipped by rail.

It must be admitted that during the past few years the railroads have done much toward popularizing electric transmission, but rates have not quite reached the point where, even under most favorable conditions in the Middle West, a power company would be warranted in maintaining a power plant at the mine, a stand-by plant in the city, and a transmission line between. Conditions, moreover, are seldom "most favorable," as with us the large quantity of flowing water necessary for condensing in a plant of upward of 50,000 kw. is seldom found at the mines. This renders it necessary to ship the coal to a power house located on a nearby river and to transmit electrically from there to the place where the power is to be used, but right here the railroads that have tried so hard to popularize all-electric transmission have unwittingly intervened with an awkward freight-schedule system, which renders a part rail and part line transmission impossible. This has happened because they did not know there was any system to their schedules, and while the author cannot say that these schedules were prepared according to any rule, he has nevertheless found a key that will fit the average of several taken at random. This key indicates that a coal freight schedule is composed of a basic charge of $1.00 a ton and a hauling charge of four-tenths of a cent per ton-mile. Let us see how this affects a rail and line transmission.

From the Springfield coal district to Chicago is 192 miles. This distance, at 0.4 cent per ton-mile, amounts to 77 cents; adding the basic $1.00 makes $1.77. The actual rate, $1.83, is a little less than 1 cent per ton-mile.

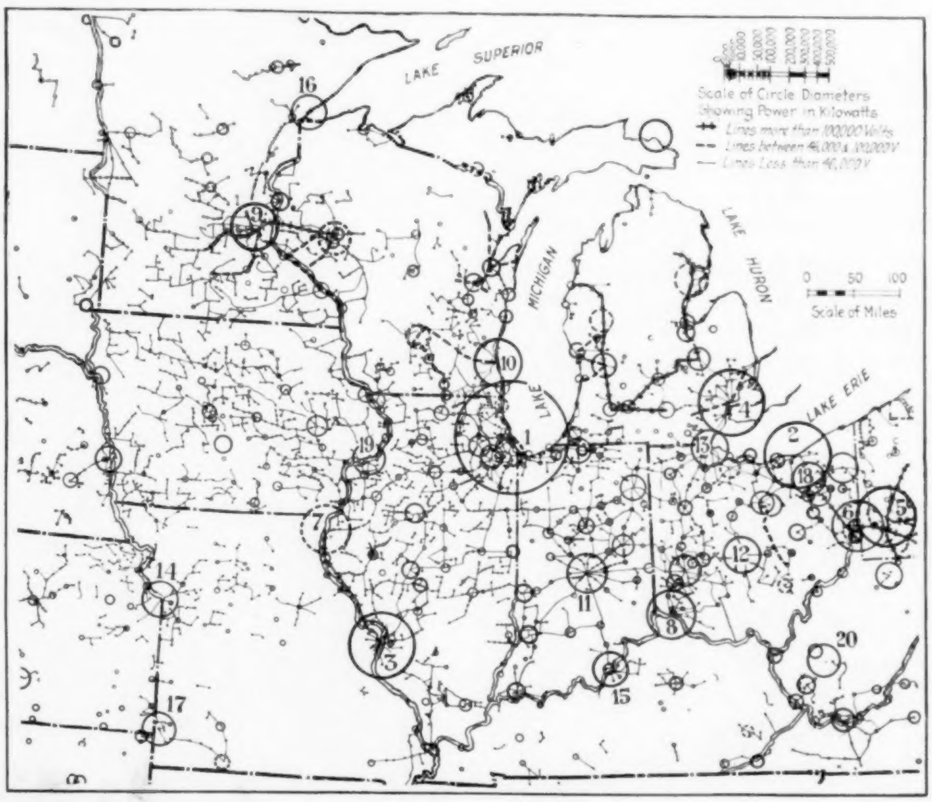

Fig. 2 Central-Station Power Distribution of the Middle-Western States

1—Chicago, Ill.
2—Cleveland, Ohio
3—St. Louis, Mo.
4—Detroit, Mich.
5—Pittsburgh, Pa.
6—Windsor, W. Va.
7—Keokuk, Iowa
8—Cincinnati, Ohio
9—St. Paul, Minn.
10—Milwaukee, Wis.
11—Indianapolis, Ind.
12—Columbus, Ohio
13—Toledo, Ohio
14—Kansas City, Mo.
15—Louisville, Ky.
16—Duluth, Minn.
17—Joplin, Mo.
18—Akron, Ohio
19—Moline, Ill.
20—Cabin Creek Jct., W. Va.

There being no dependable supply of condensing water near Springfield, it has been suggested that the coal destined for Chicago power be shipped to Peoria, where there is water in abundance, used there in power houses, and the electric energy sent to Chicago via a high-tension line.

From Springfield to Peoria is 62 miles, which at 0.4 cent is 25 cents; adding the basic $1.00 gives $1.25. The actual rate is $1.17, —a little less than 2 cents per ton-mile, or about double the ton-mile rate from Springfield to Chicago.

Obviously, the Springfield-Chicago all-rail shipments need have no fear of competition via the Springfield-Peoria-Chicago rail and line route.

Location of Power Stations and Distribution Lines in the Mid-West Territory

Fig. 2 is a map showing the distribution lines of the territory discussed and also showing by dots and circles the centers where the power is generated and used. The smallest circle shown represents 500 kw.; smaller amounts of power are indicated by dots. Central power stations of less than 500 kw. and not connected up to another center do not appear on the map. Broken circles indicate a power station, the greater part of whose output is included in the area of some solid circle. The developed central-station power of the Middle West is 4,500,000 kw., of which all but 18 per cent is from steam power.

The large circle, indicating 500,000 kw. for the central stations of Chicago and vicinity, is the dominating feature; following in order are Cleveland, St. Louis and Detroit, each with a little more than 200,000 kw. The 210,000 kw. of St. Louis is made up in part by its own Ashley Street Station and in part by the 100-000 kw. from the Keokuk dam, shown as circle 7. One significant feature of the important high-voltage transmission lines indicated in the figure is that such lines are used almost entirely to connect water powers with centers where their power is used, the exception to this being in the vicinity of Pittsburgh, where mine-pit cars dump their coal into the hoppers of boiler rooms located on river banks, and in Detroit, where a small amount of power is distributed at 46,000 volts; also a short 66,000-volt line owned by the Doherty interests in Central Ohio.

The line over which the greatest amount of power is transmitted connects the Stone & Webster Keokuk power with St. Louis at 110,000 volts. Probably the system next in importance is that of Hodenpyl & Hardy in Michigan, connecting up water powers on the Au Sable, Manistee and Grand with a line of 140,000 volts—

(Continued on page 458)

The Hardness Testing of Metals[1]

Report of a Committee of the Engineering Division of the National Research Council on Various Methods of Testing the Hardness of Metals

THE Committee on A New Hardness-Testing Machine of the Engineering Division of the National Research Council was formed at the suggestion of Dr. Henry M. Howe to obtain, if possible, more satisfactory methods of measuring the hardness of metals. The following reports were submitted to the committee in the course of its work and are published here as it is believed that they will assist others interested in hardness measurements.

Brinell Tests with Etched Ball[2]

This method, devised by Axel Hultgren, is used on hardened steel in order to obtain indentations which are easier to read than those produced with polished balls. Either 5-mm. or 10-mm. steel balls may be used. The balls are wiped free from grease and thoroughly cleaned in alcohol, and thereafter etched for 2 to 4 minutes under agitation in a solution of 1 per cent nitric acid in alcohol and cleaned again in alcohol. The hardened steel surface to be tested is ground and polished as usual, the higher the polish the better. The load—1000 kg. or 750 kg. for 5-mm. ball, 3000 kg. for 10-mm. ball—is applied as usual in a Brinell testing machine.

In reading the indentation with a Brinell microscope the light should fall at a steep angle. If polishing scratches running in one direction are left on the surface of the specimen, the light should fall in the same direction in order that the best definition of the indentation circle may be obtained. Under the conditions described, the diameter can be read with greater sharpness and more ease than when a polished ball has been used, due to the contrast between the dull indentation surface produced by the etched ball and the surrounding surface.

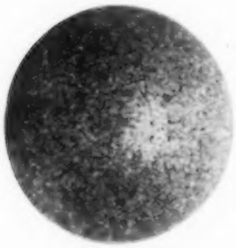

Fig. 1 Appearance of the Brinell Ball after the Polish Has Been Removed by 1 Minute's Immersion in 1 Per Cent Alcoholic Solution of Nitric Acid

The dullness is explained as follows: The ball being made of a hypereutectoid steel, the etched surface presents numerous small cementite grains standing out in relief from the matrix, which is martensite. When this surface is pressed against the surface of the specimen so as to produce an indentation, numerous small holes are formed in the latter by the cementite grains in the former. The dull appearance of the indentation is an effect of these small holes.

In order to show the advantage of using the etched ball in making Brinell hardness determinations, H. S. Rawdon of the Bureau of Standards was requested to illustrate the results photographically. He has done this and given, in addition, the discussion which follows:

To test the method a portion of a file from which the teeth had been entirely removed was used. This was highly polished as for microscopic examination. The balls were 10 mm. in diameter and indentations were obtained with a load of 1000 kg. applied for 30 seconds. The balls were etched in a 1 per cent alcoholic solution of nitric acid for two minutes.

Fig. 1 shows the appearance of one of the balls after etching. The surface pattern revealed, which resembles that of the dendritic structure of steel, may be the result of abrasion markings, caused by the grinding of the balls, which subsequently were hidden but not entirely removed by the polishing of the balls. A microscopic examination of the surface of the ball after etching reveals the structure of the material. The steel consists of innumerable particles of carbide embedded in a matrix which is probably somewhat softer than the carbide. The matrix etches more readily than the carbide so that the tiny particles of carbide stand in relief over

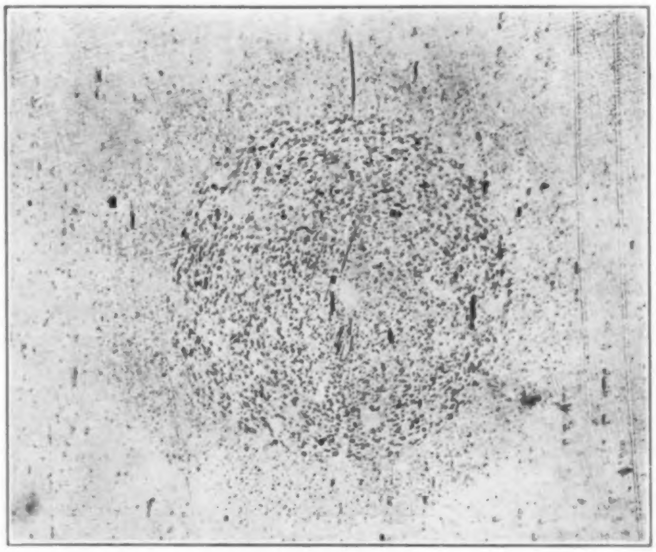

Fig. 2 Character of Brinell Indentations Obtained with Etched Balls. Magnification × 50

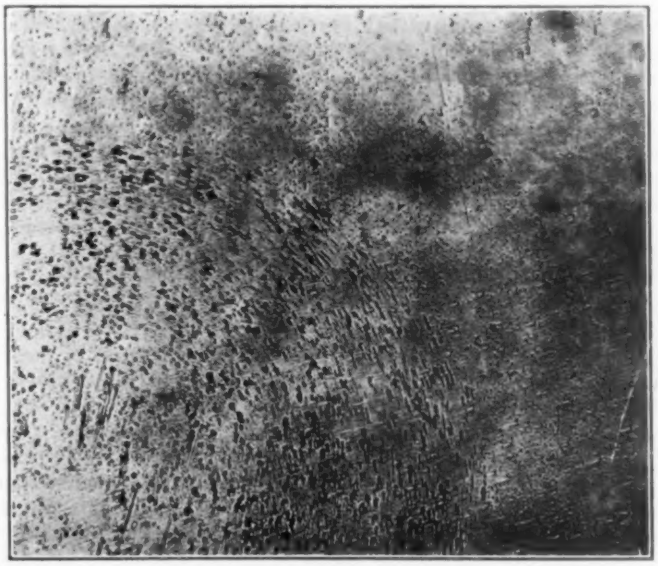

Fig. 3 Character of Brinell Indentations Obtained with Etched Balls. Magnification × 100

[1] Slightly condensed from part of the progress report of the Committee on a New Hardness Testing Machine of the Engineering Division of the National Research Council. The personnel of the committee is as follows:
Prof. H. L. Whittemore, Chairman, Bureau of Standards, Washington, D. C.
Major A. E. Bellis, Springfield Armory, Springfield, Mass.
H. C. Boynton, John A. Roebling's Sons Company, Trenton, N. J.
S. L. Cope
Alfred V. de Forest, American Chain Company, Bridgeport, Conn.
Prof. Fred E. Foss, Cooper Union, Astor Place, New York City.
F. P. Gilligan, Henry Souther Engineering Company, 11 Laurel Street, Hartford, Conn.
Prof. S. L. Goodale, 1156 Murray Hill Avenue, Pittsburgh, Pa.
Dr. P. D. Merica, International Nickel Company, Bayonne, N. J.
Prof. H. F. Moore, University of Illinois, Urbana, Ill.
Prof. John H. Nelson, Wyman & Gordon Company, Worcester, Mass.
P. M. Taft, Illinois Watch Company, Springfield, Ill.
The American Society of Mechanical Engineers has donated a bibliography on hardness, copies of which can be obtained from the chairman.

[2] From report prepared by Axel Hultgren, Svenska Kullagerfabriken, Gothenburg, Sweden.

the surface of the ball. The diameter of the ball is not reduced to any appreciable amount, as the specimen is etched only to about the same degree as is the usual practice for revealing the microstructure.

The indentation produced by the etched ball has a "matt" appearance and is readily visible when the specimen is viewed at almost any angle. The impression produced by the unetched ball is almost invisible when the light strikes the surface at certain angles, and particularly is this so when the line of vision is approximately normal to the surface.

Figs. 2 and 3 show the appearance of the spherical surface of

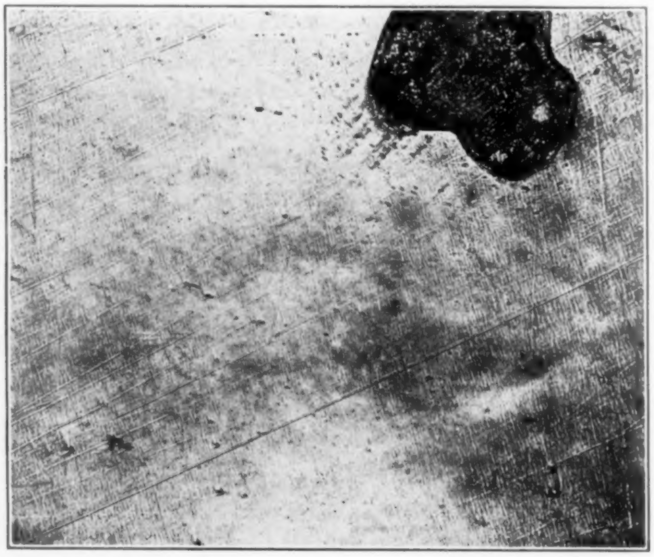

Fig. 4 Brinell Indentation on Hard Steel with Unetched Ball. Magnification × 50

an indentation obtained with the etched ball, viewed with "vertical illumination," that is, normal to the surface. It is readily seen that the matt finish is due to numerous tiny pits, caused undoubtedly by the projecting carbide particles on the surface of the etched ball. The indentation consists of two zones. In the inner one the pits are larger and more numerous than in the outer one and are often slightly elongated and arranged in concentric rings. This is caused by a slight rotary motion of the ball as the pressure is applied. The pits in the outer zone are much smaller, the line of demarcation between the two being very sharp. Fig. 3 shows the difference between the two zones of the indentation more clearly. The micrograph (×100) covers only one quadrant of the impression. Evidently the pressure applied to the ball is not transmitted equally to all parts of the metal covered by the indentation. Fig. 4 shows a view (×50) of an impression obtained with an unetched ball; the dark area is an ink spot which was placed at the center of the indentation in order to locate it. Only very slight traces of the impression can be seen, though a few pits similar to these noted in the other type of indentation may be noted. There is nothing, however, to mark the outer limit of circumference of the indentation.

If desired, an area on the surface of the specimen to be tested may be etched with alcoholic nitric acid before the indentation is made. In this case it is not necessary to etch the ball. The impressions obtained in this way are considerably more conspicuous than those obtained with an unetched ball on a polished specimen, but not quite so conspicuous as those produced by the etched ball on a polished surface.

A further advantage in the use of etched balls may be mentioned. After the indentation has been made, a bright spot remains on that side of the ball which was in contact with the material tested. This renders it an easy matter to turn the ball so that an unused, and therefore a much less distorted, portion of the ball can be employed for a subsequent hardness determination.

Impact Hardness Apparatus

One of the problems of hardness testing has been the determination of the hardness of the large masses of metal which could not be moved readily, and especially the hardness of surfaces which were vertical or in such a position that the use of the scleroscope or Brinell machine was impossible.

Impact Brinell machines in which the impact of a hand hammer is used have been devised. The blow causes a ball between the material to be tested and a material of known hardness to indent both. The hardness desired is computed from the impressions in the two materials. Two instruments of this type, the Morin apparatus and the Brinell meter, have been tested.

Morin Hardness-Testing Apparatus[1]

Description of the Apparatus. The Morin hardness-testing apparatus, Figs. 5 and 6, was tested to ascertain its practical value in determining the hardness of metals. It consists of a cylindrical case in which a steel ball, a standard cube, and a plunger are held firmly in contact in their proper relative positions by a coil spring which surrounds the plunger.

The ball, 10 mm. in diameter, projects slightly from one end of the case so that it may be brought into contact with the specimen. The plunger, projecting about one-half inch from the other end of the case, may be struck by a hammer. The standard cubes are about ½ inch in each dimension. A dozen cubes having different hardnesses are supplied by the maker. The case is so designed that the cubes may be readily put in place, or removed, without having the ball or plunger leave their places.

To make a hardness determination the standard cube is selected that has about the same hardness as the specimen. It is placed in the case, the latter held perpendicularly to the surface of the specimen and the plunger struck with a hammer (see Fig. 5). The ball, held between the standard cube and the surface, indents both of them. The diameter of the impression in the standard cube is measured, as well as that in the specimen. Knowing the two diameters and the Brinell hardness of the cube which has been determined in the usual way, a special circular slide rule provided with the instrument and shown in Fig. 6 is used to determine the hardness of the specimen.

Outline of Tests. For testing the apparatus, carbon steels were used having Brinell hardness numbers ranging from 88 to 302. Standard cubes similar to those supplied with the apparatus were prepared from the same piece of steel. Three series of tests were

Fig. 5 Morin Hardness-Testing Apparatus Ready for Use

made to determine the influence of various factors upon the hardness numeral as given by the instrument: namely,

1 The influence of variations in the energy of impact where the standard cubes and specimen are the same
2 The influence of variations in the hardness of the standard cubes where the hardness of the specimen is constant
3 The influence of variations in the hardness of the material when the hardness of the standard cube is constant.

[1] This report (Bureau of Standards Lab. No. 1118a20) was prepared by H. L. Whittemore, S. N. Petrenko, and L. B. Tuckerman.

In all the tests except Nos. 27 to 35 the blow was given by a 10-lb. sledge hammer. A pin through the handle at a distance of 3 ft. from the hammer head served as an axle. The hammer was raised the required height and then released. When dropped

TABLE 1 TESTS OF MORIN HARDNESS-TESTING APPARATUS

Test No.	Standard cube No.	Standard cube Brinell hardness	Standard cube Scleroscope hardness	Material No.	Material Brinell hardness	Material Scleroscope hardness	Morin-Brinell hardness
Series 1; Energy of Impact, 60 in-lb.							
1-a	A	88	21	A	90	22	94
1-b	B	122	24	B	119	23	113
1-c	C	147	29	C	162	28	143
1-d	D	172	30	D	175	27	168
1-e	E	187	39	E	204	27	173
1-f	F	208	41	F	220	36	208
1-g	G	218	39	G	206	30	210
1-h	H	277	48	H	275	38	262
1-i	I	300	52	I	302	48	302
Series 1; Energy of Impact, 30 in-lb.							
2-a	A	88	20	A	90	24	88
2-b	B	122	22	B	119	20	143
2-c	C	147	27	C	162	29	173
2-d	D	172	36	D	175	26	158
2-e	E	187	38	E	204	25	172
2-f	F	208	39	F	220	35	208
2-g	G	218	40	G	206	35	216
2-h	H	277	49	H	275	39	268
2-i	I	300	53	I	302	48	280
Series 2; Energy of Impact, 60 in-lb.							
3	A	88	20	I	302	48	219
4	B	122	23	I	302	48	260
5	C	147	28	I	302	48	254
6	D	172	33	I	302	50	276
7	E	187	39	I	302	50	264
8	F	208	38	I	302	48	299
9	G	218	38	I	302	47	288
10	H	277	49	I	302	47	296
11	I	300	53	I	302	48	284
12	A	88	20	B	119	28	108
13	B	101	22	B	119	26	107
14	C	147	28	B	119	23	119
15	D	172	32	B	119	25	124
16	E	187	39	B	119	24	122
17	F	208	38	B	119	24	134
18	G	218	40	B	119	25	135
19	H	277	49	B	119	23	137
20	I	200	53	B	119	24	138
21	B	101	21	E	204	33	165
22	143	143	26	E	204	32	196
23	150	150	27	E	204	33	197
24	E	185	39	E	204	33	187
25	G	206	38	E	204	28	198
26	I	306	51	E	204	28	206
Series 2; Energy of Impact, 20-30 in-lb.							
27	143	143	27	E	204	31	210
28	145	145	28	E	204	31	208
29	150	150	29	E	204	30	187
30	210	210	43	E	204	30	204
31	255	255	44	E	204	30	230
Series 3; Energy of Impact, 20-30 in-lb.							
32	150	150	28	B	119	26	130
33	150	150	29	E	204	30	185
34	150	150	29	F	220	34	190
35	150	150	30	H	275a	40	230

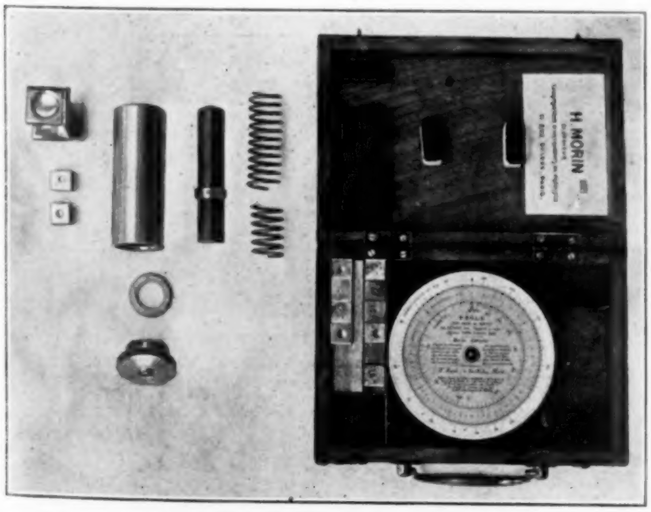

Fig. 6 Parts of the Morin Hardness-Testing Apparatus in Their Proper Relative Positions

under the influence of gravity the hammer head struck the apparatus resting on the specimen. In tests Nos. 27 to 35 the blow was given by a hand hammer weighing 1 lb.

Results of Tests. The results of the various series of tests are given in Table 1. In the last column on the table are given Morin-Brinell hardness numerals as determined by means of the slide rule provided with the apparatus. As a check on the Brinell hardness numbers, the scleroscope hardness of the standard cubes and of the specimens is given in the tables. The Brinell hardness was determined by an Alpha Brinell machine, using a 10-mm. ball and a load of 3000 kg.

In the tests of Series 1, two widely different amounts of impact energy were used. The hammer was dropped from the heights of 3 in. and 6 in., the corresponding energies of impact being 30 in-lb. and 60 in-lb., respectively. A comparison of the values in the last column of the table shows that the energy of impact has no apparent influence upon the results.

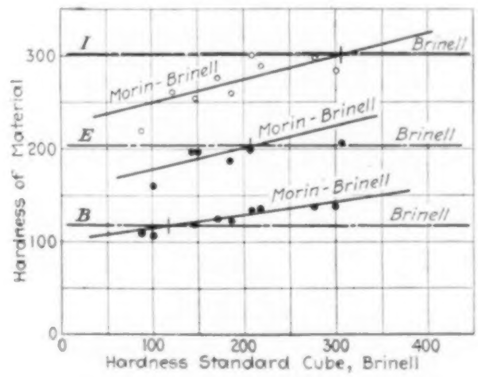

Fig. 7 Graphs of Results of Tests of Series 2; Energy of Impact, 60 in-lb.

In studying these results it should be remembered that the standard cubes and the specimens were of the same material. The slight differences in their Brinell hardnesses is due to variation in hardness of the material and to the usual errors in the determination of the hardness. The results are therefore in this respect obtained under unusually favorable conditions. On the other hand, the hardness of the test pieces was not uniform and the differences in

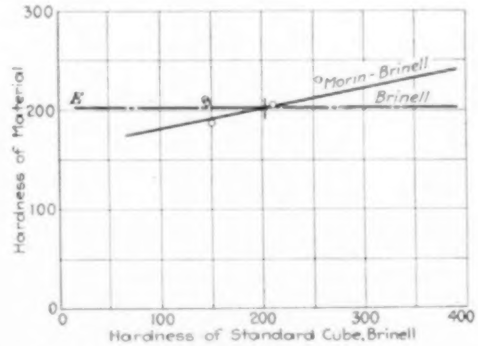

Fig. 8 Graph of Results of Tests of Series 2; Energy of Impact, 20-30 in-lb.

Morin-Brinell hardness and Brinell hardness possibly were partly due to the actual differences of hardness in various parts of the test pieces. The maximum error for the 60 in-lb. impact is 15.2 per cent and the average 5.9 per cent. For the 30 in-lb. impact the maximum error is 20.2 per cent and the average 8.3 per cent.

The difference between the Brinell hardness of the material as determined in a Brinell hardness machine and the Morin-Brinell hardness is probably not due to the energy of impact being too great or too small, but to the errors of the apparatus itself and to the variations in the hardness of the test pieces and of the standard cubes. However, it may be said that the 60 in-lb. impact gives the more consistent results. It is also to be noted that the irregularities of the readings increase with increasing hardness, perhaps due in part to the difficulty in accurately measuring the small impression.

In tests Nos. 3 to 20, Series 2, the hardest (Brinell hardness 302) as well as one of the softest (Brinell hardness 119) materials were chosen and tested with standard cubes of various degrees of hardness. The results are shown graphically in Figs. 7 and 8. In these graphs the constant Brinell hardness of the specimen is shown by the horizontal line marked "Brinell." The hardness values of

the specimen as found by the Morin apparatus are plotted as ordinates, using as abscissas the Brinell hardness of the standard cube. If results are desired which are accurate within 10 per cent it is apparent from the graphs that the hardness of the standard cube should not differ from that of the specimen by more than 100 Brinell numbers. Due to the fact that many of the Morin-Brinell values do not lie close to the plotted line among the points, it seems reasonable to reduce this difference one-half, or to 50 Brinell numbers.

In Series 3, tests Nos. 32 to 35, specimens of various hardnesses were tested with standard cubes of constant hardness (150). The results of these tests confirm the deduction from the previous tests as shown in Fig. 9.

Conclusions. From a study of the results obtained in the various series of tests the following conclusions have been arrived at:

1 The hardness obtained with a Morin hardness tester is not affected, to any considerable degree, by the amount of energy of impact. Too light a blow is likely to give more erratic results than a heavy blow, and as the correct measurement of the diameter of a small indentation is difficult, the diameter of the impression should not be smaller than 2.5 mm. or possibly 3 mm.

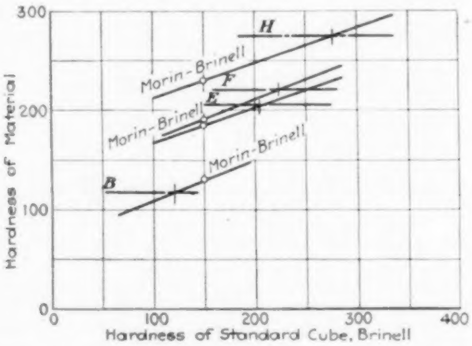

FIG. 9 GRAPH OF RESULTS OF TESTS OF SERIES 3; ENERGY OF IMPACT, 20-30 IN-LB.

2 The hardness of the standard cube should be as near that of the specimen as possible. A difference in hardness amounting to more than 50 Brinell units would be likely to make the error exceed 10 per cent. It is possible that this limitation might be removed by the use of an appropriate correction formula, but this would still further complicate the use of the apparatus.

3 The standard cubes should be uniform in hardness and their Brinell hardness should be determined before they are cut out of a bar, as any error appears in the hardness of the test piece.

4 The size of the standard cubes is too small to obtain their Brinell hardness accurately. They are distorted by the 3000-kg. load more than would be the case with larger blocks.

5 Due to the fact that each block can be used for only six readings, the time and expense required to make additional blocks is a rather serious restriction on the use of the apparatus.

6 The proximity of the hardness of the standard cube to that of the specimen to be tested is numerically of greater importance in the case of hard material than in the case of soft, as shown by the slope of the curve in Fig. 7.

THE BRINELL METER[1]

Description of the Apparatus. The Brinell Meter apparatus consisted of a cylindrical case which held the parts in their proper relative position. At one end was a 10-mm. steel ball, next a standard bar, then a plunger. These were held in contact by a coil spring which surrounded the plunger. A cap which screwed into the end of the cylinder held the parts in place. The steel ball projected from one end of the case so that it could be brought into contact with the specimen whose hardness was desired. The standard bar, approximately, ½ in. square in cross-section by 6 in. long, could be placed in position between the ball and the plunger through holes in the side of the case. The Brinell hardness number was stamped on the bar. Fig. 10 shows the apparatus ready for use and Fig. 11 the parts in approximately their relative positions.

In order to determine the hardness of a specimen, a standard bar having nearly the same hardness is placed in the apparatus so that the ball rests on an unindented portion. The apparatus, held in the hand, is placed so that the ball rests on the specimen. The plunger is then struck by a 3-lb. hand hammer.

The diameter of the indentation in the standard bar is divided by the diameter of the indentation in the specimen and special tables supplied with the instrument are used to obtain the Brinell Meter hardness of the latter. For measuring the diameters of the indentation, transparent sheet celluloid scales were provided. One of these scales had two lines about 8 cm. long, 5 mm. apart at one end and 3 mm. at the other. The lines were graduated so that one division equaled a change in distance between the lines of 1/20 mm. On the other scale the lines were respectively, 3.5 mm. and 1.5 mm. apart at the ends.

Theory of Brinell Hardness. The Brinell hardness numeral (B. h.n.) was originally defined as the ratio of the load on a sphere, used to indent the specimen, to the area of the spherical indentation produced. The hardness is calculated by the formula—

$$H = \frac{P}{\pi t D}$$

in which H is the Brinell hardness numeral, P the load on the sphere D the diameter of the sphere and t the depth of the indentation. This depth t was calculated from the observed diameter, d, of the indentation by the formula—

$$t = \frac{D}{2} - \sqrt{\frac{D^2}{4} - \frac{d^2}{4}}$$

Experiment has shown that the B.h.n. so defined varies with the load and diameter of the sphere. This is at least partially due to the elastic deformation of the sphere,[1] and it has therefore become standard practice to define the B.h.n. as the value obtained under a load of 3000 kg. with a ball of 10 mm. diameter. For soft metals a load of 3000 kg. is too great, and therefore 500 kg. has become standard practice.

Theory of the Brinell Meter. The hardness tables furnished with the Brinell Meter are evidently calculated from the formula—

$$\frac{H_1}{H} = \frac{d^2}{d_1^2}$$

in which H is the Brinell hardness of the specimen, H_1 the hardness of the standard bar, and d and d_1 are the diameters of the indentations. This is obtained as an approximation from the Brinell formula $H_1/H = t/t_1$ when the two impressions are obtained from the same load, and its use results in an extreme case in an error of about 2 per cent.

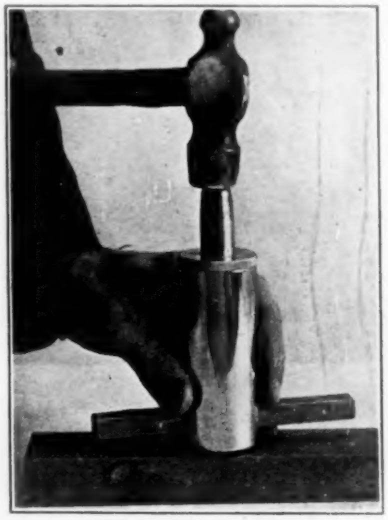

FIG. 10 BRINELL METER READY FOR USE

[1] This report, Bureau of Standards Lab. No. 1231a20 (No. 17–203 revised), prepared by H. L. Whittemore and L. B. Tuckerman, includes experimental data on the Brinell Meter obtained by T. L. Sorey.

[1] Technologic Paper, Bureau of Standards, No. 11, entitled Five Methods of Measuring Hardness.

As the accuracy of the results obtained with this apparatus depends directly upon the hardness marked upon the standard bars their hardness was determined in an Alpha Brinell machine. The values are given in Table 2.

Outline of Tests. For convenience it was decided to test the Brinell Meter first under static loads. An Olsen testing machine was used to apply loads to the Brinell Meter resting upon a specimen. In this way the effect of different loads on the accuracy of the static hardness reading can be determined. The diameters of the impressions in both the specimens (d_1) and that in the standard bar (d) were measured with a micrometer microscope such as is supplied with an Alpha Brinell machine. The data are given in Table 3. The hardness of the specimen was calculated by the formula $H_1 = Hd^2/d_1^2$.

Since these results showed that so far as static loads were concerned the Brinell Meter could be relied upon within 2 per cent over a wide range of loads, the apparatus was then tested by hammer blows for which it was designed. The results of these tests are given in Table 4.

TABLE 2 HARDNESS OF STANDARD BARS; DIAMETER OF BALL, 10 MM.

Marked hardness	Load, kg.	Indentation diameter, mm.	Brinell hardness	Average	Error in marked hardness, per cent
430	3,000	2.95	430	429	0.23
430	3,000	2.96	428		
430	3,000	2.95	430		
360	3,000	3.20	364	364	−1.1
360	3,000	3.20	364		
240	3,000	3.93	237	236	1.7
240	3,000	3.96	234		
163	3,000	4.62	168	169	−3.6
163	3,000	4.61	169		
97	500	2.78	81	82	18.0
97	500	2.77	82		
58	500	3.48	51	51	14.0
58	500	3.50	50		
97	1,500	4.39	94	94	3.2
97	1,500	4.41	93		
58	1,000	4.50	60	61	−4.9
58	1,000	4.45	61		

TABLE 3 EFFECT OF LOAD ON BRINELL METER HARDNESS

Load, kg.	Indentation diam., mm. Bar d	Indentation diam., mm. Specimen d_1	Ratio $\frac{d}{d_1}$	Specimen: Brinell meter hardness	Specimen: Hardness by Brinell formulas	Variation of Brinell Meter hardness from standard Brinell hardness, per cent
Test 1,	Standard bar (marked 240), 223 Brinell hardness, Specimen, 262 Brinell hardness.					
3000[1]	4.05	3.75	1.08	260	262	−0.76
2800	3.95	3.65	1.082	261	258	1.15
2600	3.76	3.51	1.072	256	260	−1.56
2400	3.60	3.38	1.065	253	259	−2.37
2200	3.46	3.25	1.065	253	257	−1.58
2000	3.32	3.15	1.054	248	250	−0.81
1800	3.15	3.02	1.045	244	247	−1.23
1600	2.99	2.85	1.048	245	245	0
1400	2.79	2.64	1.057	249	251	−0.80
1200	2.55	2.42	1.054	248	257	−3.63
1000	2.38	2.26	1.053	247	246	0.40
Test 2,	Standard Bar (marked 360), 354 Brinell hardness Specimen, 259 Brinell hardness					
3000	3.24	3.77	0.859	261	259	0.77
2800	3.13	3.66	0.855	259	257	0.77
2600	3.02	3.49	0.866	265	263	0.77
2400	2.90	3.39	0.856	259	258	0.39
2200	2.76	3.25	0.849	255	257	−0.78
2000	2.64	3.13	0.844	252	253	−0.40
1800	2.53	2.95	0.858	261	258	1.15
1635	2.44	2.85	0.856	259	251	3.09
1400	2.26	2.63	0.860	262	252	3.82
1200	2.09	2.46	0.850	256	249	2.73
1000	1.93	2.29	0.843	252	240	4.77
Test 3,	Standard bar (marked 360), 349 Brinell hardness, Specimen, 268 Brinell hardness.					
3000	3.26	3.71	0.879	269	268	0.37
2000	2.69	3.14	0.857	256	251	1.83
1000	1.96	2.29	0.856	256	240	6.26
500	1.43	1.69	0.846	250	221	11.5
Test 4,	Standard bar (marked 250), 261 Brinell hardness, Specimen, 187 Brinell hardness.					
3000	3.76	4.40	0.855	191	187	2.09
2000	3.12	3.66	0.853	190	183	3.68
1000	2.31	2.67	0.865	195	175	10.25
500	1.69	1.99	0.850	189	159	15.90
Test 5,	Standard bar (marked 120), 124.4 Brinell hardness at 2170 kg. Specimen, 63 Brinell hardness at 2170 kg.					
2170[2]	4.58	6.25	0.733	67	62.9	6.12
1500	3.85	5.37	0.717	64	61.5	3.91
1000	3.30	4.67	0.707	62	55.0	11.30
500	2.29	3.36	0.682	58	54.8	5.52

[1] Standard load.
[2] Not standard load.

Conclusions. 1 The dimensions of the standard bars are so small as to cause error in measuring their hardness in the usual manner. It would seem that a cross-section of at least twice the dimensions would be preferable.

TABLE 4 COMPARISON OF BRINELL METER AND ALPHA BRINELL HARDNESS (HAMMER BLOWS ON BRINELL METER)

Standard bar marked	Indentation diameter, d	Indentation diameter, d_1	Ratio d/d_1	Brinell Meter hardness	Alpha Machine indentation diameter	Brinell hardness	Variations in Brinell Meter hardness	Variation in Brinell Meter hardness from Brinell hardness
	mm.	mm.			mm.		per cent	per cent
430	3.08	2.95	1.044	469	2.78	484	0.4	
	3.05	2.95	1.034	460	2.77	488		
			Average	464.5		486		−4.3
360	3.21	2.89	1.111	445	2.84	464	0.4	
	3.02	2.69	1.122	454	2.84	464		
			Average	449.5		464		−2.7
360	3.21	3.05	1.052	399	2.98	423	0.0	
	3.25	3.05	1.065	408	2.98	423		
			Average	403.5		423		−4.6
240	3.56	3.07	1.16	323	3.25	351	0.4	
	3.81	3.27	1.165	326	3.24	354		
			Average	324.5		352.5		−8.0
240	3.68	3.69	0.998	239	3.86	247	0.0	
	3.81	3.76	1.013	246	3.86	247		
			Average	242.5		247		−1.8

2 A variation in the applied load causes a slight change in the hardness numeral, but Table 3 shows that in most cases for the static load tests the Brinell Meter hardness was practically identical with the Brinell hardness if the standard load of 3000 kg. was used. Both values decrease with decreasing loads, and the decrease in the Brinell hardness emphasizes the necessity for using the standard load of 3000 kg. for hard and a load of 500 kg. for soft metals.

3 The errors in the Brinell Meter hardness due to variations in load are less than for the Brinell hardness.

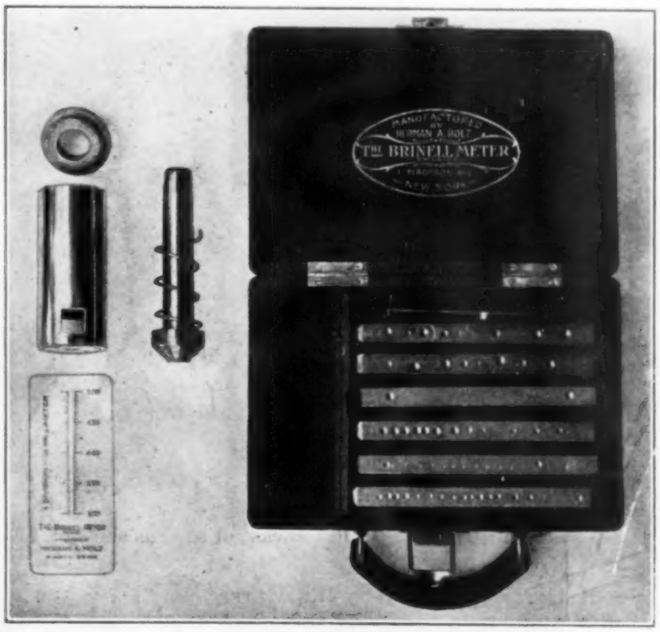

Fig. 11 Parts of the Brinell Meter in Their Proper Relative Positions

4 The greatest accuracy is obtained when the diameter of the indentations for the Brinell Meter is approximately that obtained on the same material in a Brinell testing machine under standard load.

5 The celluloid scales should not be used to measure the diameter of the indentations. A micrometer microscope graduated to tenths of a millimeter, which division allows hundredths of a millimeter to be easily estimated, will be found suitable for the purpose.

Efficiency Tests of a 30,000-Kw. Steam Turbine

By HERBERT B. REYNOLDS,[1] NEW YORK, N. Y.

During 1920 three 30,000-kw. General Electric turbines were installed at the 59th Street power station of the Interborough Rapid Transit Company, New York City, complete tests upon one of which form the subject of the present paper.

These turbines are of the straight Curtis impulse type, having 20 pressure stages, each pressure stage consisting of one velocity stage. The normal steam pressure at the throttle is 225 lb. per sq. in., abs., the steam being superheated 150 deg. fahr., and exhausted into a vacuum of 29 in. Hg. The speed is 1500 r.p.m. Novel spring supports were provided for the condenser which are described in the paper.

The highest water rate obtained during the tests while operating under normal conditions was 11.03 lb. per kw-hr., while the highest Rankine-cycle and thermal efficiencies obtained were 75.5 per cent and 25 per cent, respectively. Results of tests on the condensers and auxiliaries are also given in the form of tables.

The results obtained in these tests of a large power-station unit form a welcome addition to the data of tests of turbines of the same capacity installed in 1915 at the 74th Street power station of the company, reported in a paper presented before the Society in 1916, by H. G. Stott and W. S. Finlay, Jr.

In order to provide additional power capacity for the new subways constructed in New York City during the period from 1913 to 1921, and operated by the Interborough Rapid Transit Company, additional turbine units were installed in both the 59th Street and 74th Street Power Stations. The three 30,000-kw. Westinghouse cross-compound turbines which were completed in 1915 were among the new units installed at the 74th Street Power Station. The results of the tests upon these three turbines were presented before the Society by H. G. Stott and W. S. Finlay, Jr., in 1916.[1]

At the 59th Street Power Station, the installation of three 30,000-kw. General Electric turbines has been completed within the past year. Very complete tests have been conducted upon these added units, the results of which are set forth on the following pages.

Reviewing briefly the history of the developments at the 59th Street Power Station, it will be recalled that the original engine-room equipment consisted of nine 7500-kw. maximum-capacity Manhattan type Allis-Chalmers double angle compound engine units, and three Westinghouse 1250-kw. turbines, the latter driving 60-cycle generators which supplied 60-cycle current for subway lighting. The use of this current for lighting was subsequently discontinued and in its place 25-cycle current is now used which is taken from the main units. During 1909 and 1910, five low-pressure 7500-kw. maximum-capacity General Electric turbine units were added, taking exhaust steam from five of the engines at atmospheric pressure. A description of these units and a full report of the tests which were conducted on them are given in a paper presented by H. G. Stott and R. J. S. Pigott before the Society in 1910.[2] The units most recently installed in the 59th Street Power Station are the three 30,000-kw. General Electric turbines mentioned above.

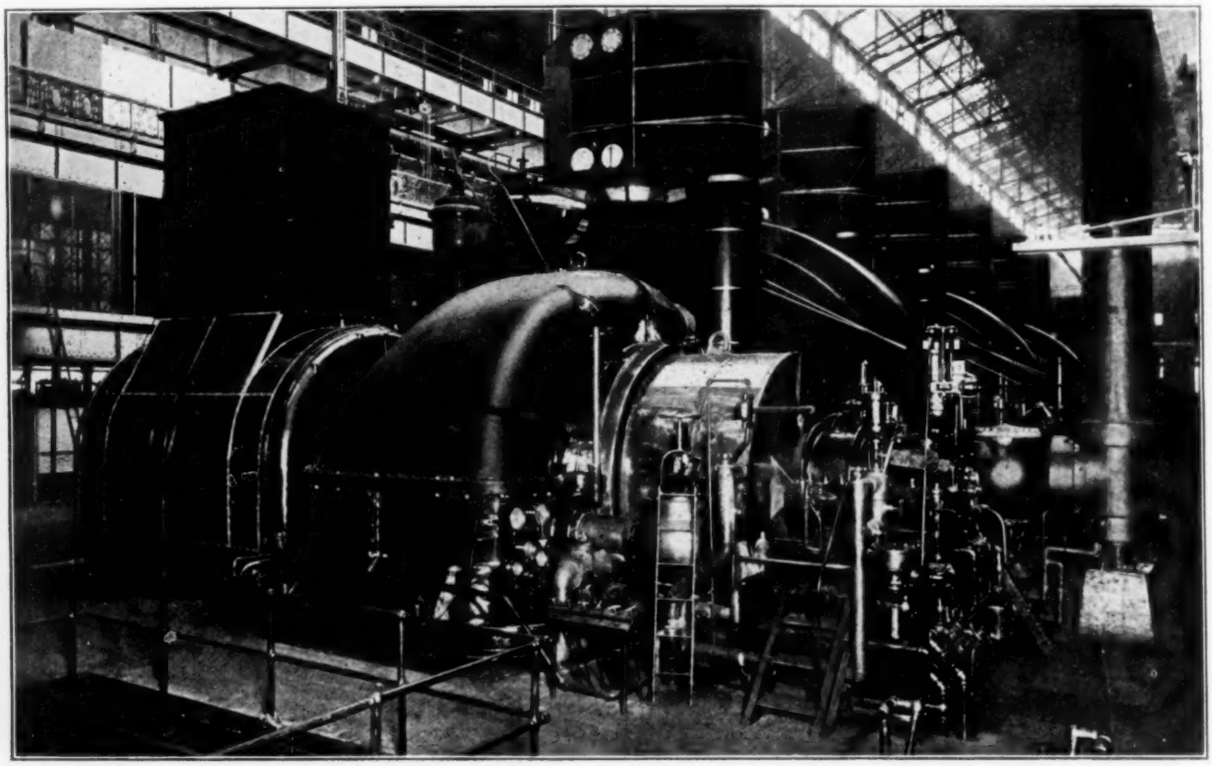

Fig. 1 One of the Three 30,000-Kw. Turbines Installed at the 59th St. Power Station of the Interborough Rapid Transit Co. in 1920

The Turbine Units

Two of the 30,000-kw. units, Nos. 7 and 8, were installed in the space formerly occupied by the three lighting units mentioned in the preceding paragraph, while the third turbine, unit No. 12,

[1] Mechanical Research Engineer, Motive Power Dept., Interborough Rapid Transit Co.

Paper presented at the Spring Meeting, Chicago, May 23 to 26, 1921, of The American Society of Mechanical Engineers. Slightly abriged. All papers are subject to revision.

[1]Trans. Am.Soc.M.E., vol. 38, page 655.
[2]Trans. Am.Soc.M.E., vol. 32, page 69.

see Fig. 1, was installed at the western end of the station. The great concentration of power possible with modern turbines is strikingly shown by the space they require as compared with that for reciprocating engines. The maximum capacity of the engines visible in the figure is but 26,250 kw. while that of the turbine in the foreground is 35,000 kw.

The general arrangement of unit No. 12, upon which the tests were conducted, is shown in Fig. 2. The turbines are of the straight Curtis impulse type, having twenty pressure stages, each pressure stage consisting of one velocity stage. Fig. 1 is a close view of the governor end of the turbine and shows the auxiliary oil pump, etc. driven by a small steam turbine, the speed of which is automatically controlled by the oil pressure. In addition to the cooling effect of the oil, the bearings are further cooled by the circulation of condensate through water jackets.

As all auxiliaries in the station are steam-driven, a connection has been provided in the turbine through which any excess auxiliary steam may be injected. This connection is at the 16th stage of the turbine.

The generators are three-phase, star-connected, generating 25-cycle current at 11,000 volts. Excitation current is furnished at 250 volts. The generators are cooled by a circulation of air

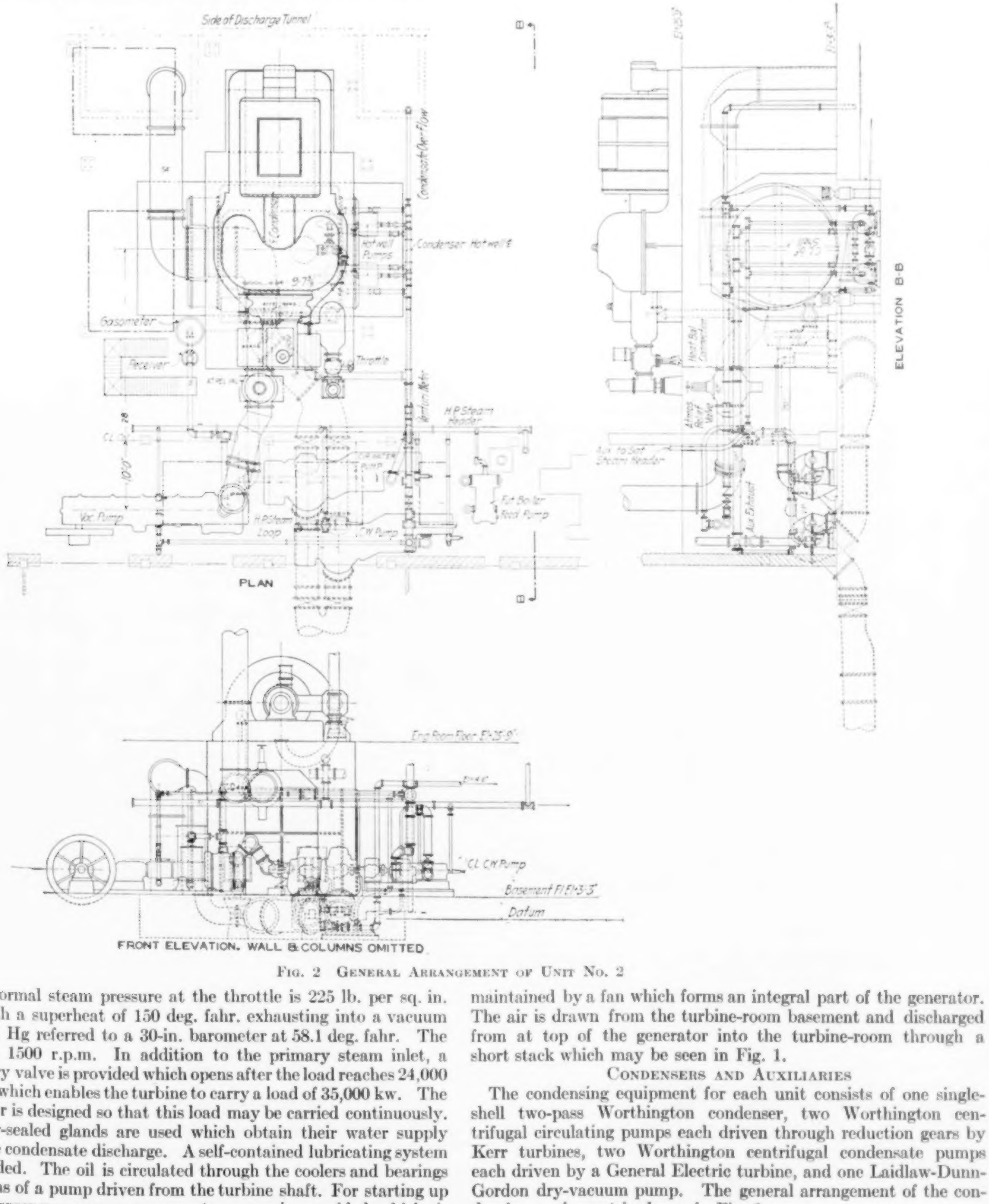

FIG. 2 GENERAL ARRANGEMENT OF UNIT NO. 2

The normal steam pressure at the throttle is 225 lb. per sq. in. abs., with a superheat of 150 deg. fahr. exhausting into a vacuum of 29 in. Hg referred to a 30-in. barometer at 58.1 deg. fahr. The speed is 1500 r.p.m. In addition to the primary steam inlet, a secondary valve is provided which opens after the load reaches 24,000 kw. and which enables the turbine to carry a load of 35,000 kw. The generator is designed so that this load may be carried continuously.

Water-sealed glands are used which obtain their water supply from the condensate discharge. A self-contained lubricating system is provided. The oil is circulated through the coolers and bearings by means of a pump driven from the turbine shaft. For starting up and emergency purposes a separate pump is provided which is maintained by a fan which forms an integral part of the generator. The air is drawn from the turbine-room basement and discharged from at top of the generator into the turbine-room through a short stack which may be seen in Fig. 1.

CONDENSERS AND AUXILIARIES

The condensing equipment for each unit consists of one single-shell two-pass Worthington condenser, two Worthington centrifugal circulating pumps each driven through reduction gears by Kerr turbines, two Worthington centrifugal condensate pumps each driven by a General Electric turbine, and one Laidlaw-Dunn-Gordon dry-vacuum pump. The general arrangement of the condensing equipment is shown in Fig. 2.

Each condenser contains 50,000 sq. ft. of tube surface made up of 10,760 tubes 18 ft. long, 1 in. in outside diameter and of No. 18 B. W. G. thickness. The condenser is of the two-pass type, the water entering the bottom and passing out from the top. As the condensers are mounted on springs, rubber expansion joints are inserted in the circulating-water lines.

Each circulating-water pump is capable of delivering 30,000

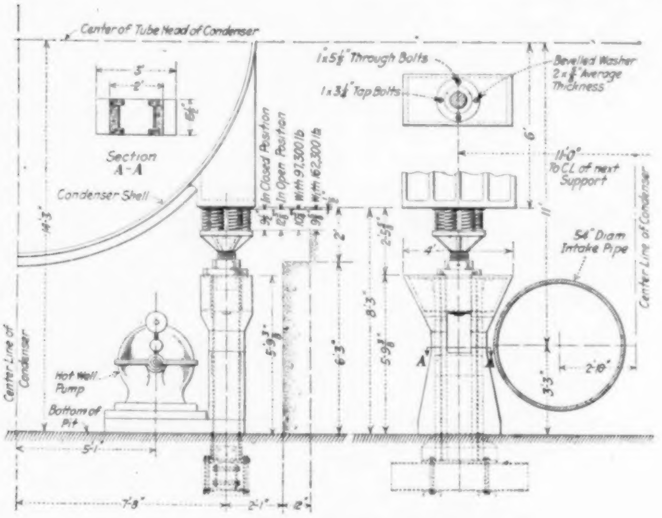

FIG. 3 SPRING SUPPORTS FOR CONDENSER

gal. of water per min. against a total head of 37 ft. The turbines which drive these pumps operate at 3950 r.p.m. This speed is reduced to 395 r.p.m. through Kerr reduction gears. The impellers are made of bronze and are of the enclosed or shrouded design.

Each condensate pump is capable of delivering 950 gal. per min. against a discharge head of 60 ft. The turbine and pump both operate at a speed of 1500 r.p.m.

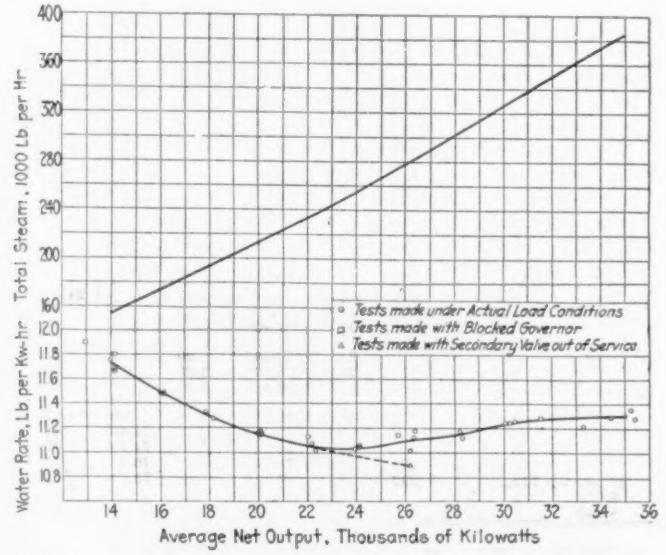

FIG. 4 WATER-RATE CURVE AND WILLANS LINE FOR 30,000-KW. TURBINE

Steam pressure, 225 lb. abs.; superheat, 150 deg. fahr.; vacuum, 29 in. Hg, referred to a 30-in. barometer; water-rate factor, 0.985. Curve based on tests Nos. 10 to 44, inclusive (excluding special tests with blocked governor and test with secondary valve out of service).

The dry-vacuum pumps are of the single rolling-mill frame two-stage rotative type, with poppet-valve steam cylinder and two-stage water-jacketed vacuum cylinder.

FOUNDATIONS

Two of the units, Nos. 7 and 8, were installed on the foundations which formerly carried the three 1250-kw. 60-cycle lighting units mentioned earlier. However, it was necessary to alter these foundations to some extent in order to receive the new turbines. The third turbine, unit No. 12, was installed on new structural-steel foundations encased in concrete.

As no expansion joint was provided between the turbine and condenser, it was necessary to mount the condenser on spring supports so as to take care of the expansion and contraction. These spring supports are shown in Fig. 3.

In order to facilitate the setting of these springs and also to provide a means for detecting and adjusting for any fatigue which might occur in them, hydraulic jacks were incorporated in the condenser supports as shown in Fig. 3. As the procedure followed in setting these springs may be of general interest, a brief description will be given. After the erection of the condenser and circulating-water pipe had been completed, with the exception of making the

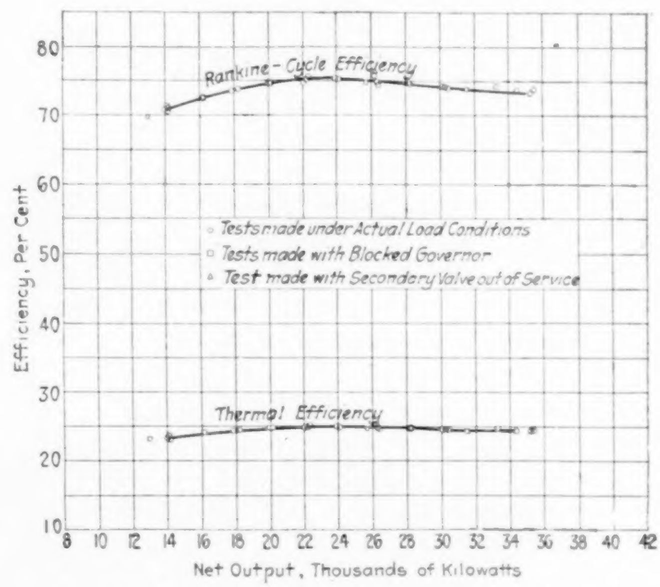

FIG. 5 RANKINE-CYCLE AND THERMAL EFFICIENCY CURVES FOR 30,000-KW. TURBINE

Steam pressure, 225 lb. abs.; superheat, 150 deg. fahr.; vacuum, 29 in. Hg, referred to 30-in. barometer. Curves based on tests Nos. 10 to 44, inclusive (excluding special tests with blocked governor and test with secondary valve out of service).

joint between the condenser and turbine, the condenser was raised while empty, by means of the jacks, leaving 3/8 in. clearance

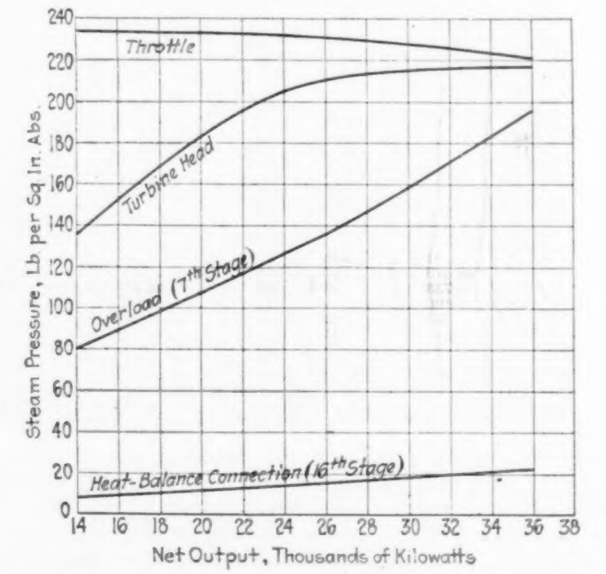

FIG. 6 VARIATION OF STEAM PRESSURE WITH THE LOAD AT VARIOUS POINTS THROUGHOUT THE TURBINE

(Based on tests Nos. 10 to 44 inclusive.)

between the face of the turbine outlet and the face of the condenser inlet. The load on each of the four supports was then determined by noting the oil pressure in the jacks. It was decided that, with the

condenser empty and cold, the downward pull on the turbine should not be less than approximately 17 tons. The distance that the joint between turbine and condenser would have to be pulled in order to give this load was estimated from the modulus of elasticity of the turbine and condenser metal. The condenser was then raised to within the predetermined distance of the turbine outlet, which was found to be 0.231 in., after which the lock nuts on the jacks were screwed home and the condenser bolted to the turbine. The load on the springs was then determined with the condenser still empty by noting the pressure required to just raise the lock nuts. Every few months the load carried by the springs will be determined in this manner and compared with the load which existed when the condenser was first bolted to the turbine. Any fatigue which may develop in the springs will be compensated for by screwing the lock nuts down.

It was found that the minimum condenser load carried by the turbine with the condenser shell empty was approximately 17 tons, which checked with the established minimum. As the water required to fill the condenser amounts to approximately 60 tons, the load on the turbine increases to 77 tons when the circulating-water pumps are started. However, as the result of a slight expansion of the condenser which takes place when it is warmed up, the springs are compressed and a small part of this load is transferred to the supports, reducing the load on the turbine to approximately 70 tons under operating conditions. Immediately after shutting down and while the condenser is still warm but drained, the load on the turbine is reduced to 10 tons. It will thus be seen that the condenser load on the turbine varies from 10 to 77 tons. The total weight of the condenser varies from 180 to 240 tons.

Turbine Tests

The equipment used for conducting the turbine tests consisted of two large water-weighing scales for measuring the steam consumption, three single-phase rotating standard watt-hour meters for measuring the output, and all the necessary thermometers, gages and mercury columns for determining temperatures, pressures and vacua as recorded in this report.

The water-weighing scales had a capacity of about 25,000 lb. each. These scales were very carefully calibrated several times throughout the tests by standard test weights and the total steam consumption corrected accordingly. The rotating standard watt-hour meters which were used for measuring the output were calibrated before and after the tests by the Electrical Testing Laboratories, New York City. It is believed that both the input and output were measured within an accuracy of 0.25 per cent. All thermometers and gages were also calibrated in the usual manner. The specific gravity of the mercury used in the vacuum columns was determined and corrections made accordingly. The readings obtained from the mercury columns were further corrected for me-

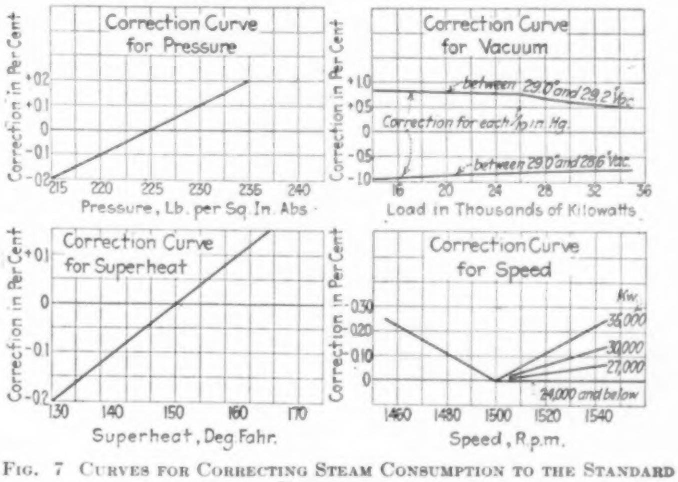

Fig. 7 Curves for Correcting Steam Consumption to the Standard Conditions

TABLE 1 SUMMARY OF TURBINE TEST RESULTS

Test No.	Load Average, net kw.	Duration hr.	Steam Pressures, lb. per sq. in. abs.: Throttle	Turbine head	Overload, 7th stage	Heat-balance connection, 16th stage	Exhaust vacuum in. Hg[1]	Steam temp. at throttle, deg. fahr.	Superheat, deg. fahr.	Water, actual total, lb.	Water, corr. total,[2] lb.	Output, gross total, kw-hr.	Excitation,[3] kw-hr.	Output, net total, kw-hr.	Water rate corr.,[2] lb. per kw-hr.	Rankine cycle efficiency,[2] per cent	Thermal efficiency,[2] per cent
36	13,985	3	237	138	82	8.13	29.00	551	155	489,140	492,786	42,118	162	41,956	11.75	70.80	23.46
44	14,146	3	231	142	79	7.60	28.94	537	143	501,560	495,858	42,608	171	42,437	11.68	71.23	23.60
20	14,161	3	231	134	80	7.88	28.99	550	156	498,125	501,233	42,643	161	42,482	11.80	70.51	23.36
33	14,175	3	236	136	81	8.08	28.92	559	163	492,215	495,984	42,686	161	42,525	11.66	71.36	23.64
32	16,165	3	233	150	87	8.78	28.92	548	153	557,730	556,228	48,664	168	48,496	11.47	72.54	24.04
21	16,181	3	229	149	89	8.81	28.97	548	155	555,710	557,438	48,712	169	48,543	11.48	72.47	24.02
10	17,889	3	235	165	95	10.33	28.90	498	103	640,452	607,640	53,845	178	53,667	11.32	73.50	24.38
25	18,243	3	227	166	99	10.25	28.96	546	153	617,170	617,047	54,905	176	54,729	11.28	73.76	24.44
24	20,142	3	229	182	108	11.61	28.96	524	131	688,785	674,156	60,611	185	60,426	11.16	74.55	24.70
11	20,150	3	235	188	114	11.63	28.93	501	105	706,687	673,677	60,636	186	60,450	11.14	74.69	24.74
12	22,065	3	224	196	119	12.87	28.87	513	122	764,761	735,842	66,389	194	66,195	11.12	74.82	24.80
35	22,217	3	232	194	114	12.38	29.00	552	157	731,290	737,485	66,848	196	66,652	11.07	75.16	24.91
23	22,366	3	228	198	117	12.22	28.95	520	127	758,280	738,560	67,293	196	67,097	11.01	75.57	25.04
13	23,945	3	233	207	124	13.75	28.96	518	123	814,978	792,241	72,038	201	71,837	11.03	75.43	25.00
22	24,151	3	227	206	124	13.48	28.99	523	130	815,910	799,598	72,657	203	72,454	11.04	75.36	24.97
42	24,159	3	228	212	119	13.40	29.01	514	121	822,875	800,735	72,681	203	72,478	11.05	75.29	24.95
34	26,206	3	231	216	132	14.92	28.92	540	146	873,350	865,389	78,830	213	78,617	11.01	75.57	25.04
19	26,357	3	224	207	141	15.28	29.01	519	127	898,485	878,714	79,284	213	79,071	11.12	74.82	24.79
14	26,400	3	228	216	139	15.31	28.91	526	133	905,215	884,344	79,425	224	79,201	11.17	74.49	24.68
15	28,244	3	228	216	151	17.02	28.95	523	130	968,485	946,341	84,954	223	84,731	11.17	74.49	24.68
18	28,249	3	225	211	159	18.71	28.84	518	126	979,565	944,796	85,269	221	85,048	11.11	74.89	24.81
30	30,098	3	224	212	161	17.93	29.00	527	136	1,028,595	1,014,193	90,523	228	90,295	11.23	74.09	24.55
43	30,289	3	225	222	161	17.20	28.97	516	124	1,048,920	1,020,053	91,100	233	90,867	11.23	74.09	24.55
17	30,470	3	223	212	165	18.45	29.02	514	123	1,055,025	1,027,989	91,641	231	91,410	11.25	73.96	24.50
41	33,301	3	225	222	177	20.16	28.84	502	110	1,177,895	1,119,672	100,148	245	99,903	11.21	74.22	24.59
40	34,448	3	224	221	186	20.67	28.96	498	106	1,221,695	1,166,630	103,600	255	103,345	11.29	73.63	24.40
37	35,254	3	224	217	191	21.84	29.03	497	105	1,253,160	1,200,517	106,023	260	105,763	11.35	73.30	24.29
31	35,467	3	224	216	193	21.53	28.99	521	130	1,224,235	1,199,055	106,660	258	106,402	11.27	73.82	24.46
26[4]	12,991	2	235	128	75	8.35	28.98	538	142	311,700	309,257	26,085	103	25,982	11.90	69.92	23.17
29[4]	20,073	2	217	178	105	11.42	29.03	528	139	452,960	448,298	42,270	125	40,145	11.17	74.49	24.68
28[4]	25,733	2	226	209	136	13.23	28.97	519	127	587,150	572,718	51,605	140	51,465	11.13	74.75	24.77
16[5]	26,196	3	228	225	133	14.62	28.94	533	140	867,385	855,156	78,798	210	78,588	10.88	76.47	25.34
27[4]	31,568	2	223	212	171	12.13	28.99	521	130	727,290	712,192	63,292	156	63,136	11.28	73.76	24.44
38[6]	No load	0.5	234	23	17		28.15	499	104	8,925			22				
39[7]	No load	0.5	234	23	17		27.93	502	107	8,045							

[1] Referred to 30-in. barometer at 58.1 deg. fahr.
[2] As corrected to 225 lb. per sq. in. abs. pressure, 150 deg. fahr. superheat, 29 in. Hg vacuum ref. to 30-in. barometer at 58.1 deg. fahr.
[3] Including rheostat loss.
[4] Tests Nos. 26, 27, 28 and 29 made with operating governor adjusted to limit maximum loads to the values shown in the second column.
[5] Test No. 16 made with secondary valve out of service.
[6] Test No. 38 made without load on generator, with generator field current adjusted to give normal voltage on open circuit.
[7] Test No. 39 made without load on generator, generator field not excited.

niscus, temperature, and barometer reading. The barometer reading was obtained from the local U. S. Weather Bureau.

Most of the tests were of three hours' duration. With the exception of a few special tests, the turbine was operated under normal conditions in so far as type of load was concerned. The load was controlled from the switchboard through the remote governor-control system provided for that purpose. This method of controlling the load subjected the turbine to the full swings of the railroad load.

Table 1 gives the numerical results of the turbine tests, while the performance is shown graphically in Figs. 4, 5, and 6. Fig. 4 gives the total steam consumption and water rate of the unit, while Fig. 5 gives the thermal and Rankine-cycle efficiencies. From these curves it will be seen that the lowest water rate obtained while operating under normal conditions was 11.03 lb. per kw-hr., while the highest Rankine and thermal efficiencies obtained were 75.5 per cent and 25.0 per cent, respectively. As stated above, all tests with the exception of seven were conducted under operating conditions.

In order to determine the effect of the swinging load on the steam consumption, four tests were conducted with the governor blocked so that the unit operated under a steady load. These tests are shown in Figs. 4 and 5 by the small squares. It will be seen that there is no improvement in the efficiency under the steady load conditions at the loads selected for these tests. When

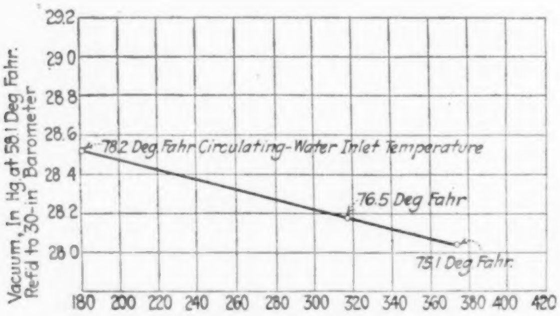

FIG. 8 CURVE SHOWING VACUUM OBTAINED DURING CONDENSER TEST

Based on tests Nos. 2, 3 and 4. Circulating-water inlet temperature varied from 5.1 deg. fahr. to 78.2 deg. fahr. Condenser_surface. 50,000 sq. ft.

the turbine is operating under normal conditions and carrying loads from 22,000 kw. to 25,000 kw. the secondary valve is continually opening and closing, which no doubt reduces the economy somewhat. If steady load tests had been conducted within this range the points would have probably fallen on the dotted curve. The test shown by the small triangle in Figs. 4 and 5 was run with the secondary or overload valve closed and out of commission, while the load was adjusted so that the primary valve was wide open. As is to be expected, the lowest water rate was obtained while operating in this manner. Since the completion of these tests the governor cams have been modified so that the opening of the secondary valve is delayed. This may improve the economy to some extent near and at the best load point; however, no tests have been conducted to determine just how much improvement has been accomplished.

Test No. 38 was run without any load on the generator, but with the field excited to give normal voltage on open circuit. The actual steam consumption per hour during this test amounted to 17,850 lb. Another no-load test was conducted, but without any excitation, during which the actual steam consumption amounted to 16,090 lb. per hour. No attempt was made to correct the steam consumption during these two no-load tests, due to the vacuum being low and outside the range of the correcting curves.

TABLE 2 SUMMARY OF CONDENSER AND DRY-VACUUM-PUMP TESTS

Number of Test	2	3	4
CONDENSER TESTS			
Average load, lb. steam per hour	180,666	317,000	373,666
Duration of test, hours	3	3	3
Barometer, at 58.1 deg. fahr.	29.93	29.93	30.07
Superheat at turbine throttle, deg. fahr.	41	44	50
Steam pressure at turbine throttle, lb. per sq. in. abs.	230	225	225
Vacuum, in. Hg. at 58.1 deg. fahr. referred to 30-in. barometer	28.51	28.17	28.04
Temperature corresponding to vacuum, deg. fahr.	91.6	98.3	100.6
Temperature of circulating water in, deg. fahr.	78.2	76.5	75.1
Temperature of circulating water out, deg. fahr.	83.0	86.3	86.4
Rise in temperature of circulating water, deg. fahr.	4.8	9.8	11.3
Temperature of condensate water, deg. fahr.	87.0	91.3	91.5
Circulating water (two pumps running), gal. per min.	72,500	61,500	63,800
Heat transferred per hour, B.t.u.	174,144,000	301,277,000	360,662,000
Heat transferred per hour per sq. ft. surface, B.t.u.	3483	6025	7213
Mean temperature difference (log.), deg. fahr.	10.8	16.36	19.4
Heat transferred per sq. ft. surface per hour per deg. mean temperature difference	322	368	372
DRY-VACUUM-PUMP TESTS			
Vacuum at pump, in. Hg. at 58.1 deg. fahr. referred to 30 in. barometer	28.58	28.55	28.56
Temperature of air and vapor entering pump, deg. fahr.	82	82	82
Temperature of air and vapor leaving pump, deg. fahr.	185	167	160
Temperature of jacket water entering pump, deg. fahr.	68	63	63
Temperature of jacket water leaving pump, deg. fahr.	89	73	71
Speed of pump, r.p.m.	48	47	48
Steam pressure at throttle, lb. per sq. in. abs.	209	207	208
Superheat at throttle, deg. fahr.	11	17	20
Steam pressure at exhaust, lb. per sq. in. abs.	15.8	15.9	15.6
Steam consumption, lb. per hr. corrected to 225 lb. abs. steam pres., 150 deg. fahr. superheat, 16 lb. abs. exhaust pressure	1088	1029	964
Air discharged, cu. ft. per min. at 60 deg. fahr.	9.94	9.47	6.50

TABLE 3 SUMMARY OF CIRCULATING-WATER-PUMP TESTS

ECONOMY TEST[1]	
Duration of test, hours	2
Barometer, at 58.1 deg. fahr.	29.78
Steam pressure at throttle, lb. per sq. in. abs.	221
Superheat at throttle, deg. fahr.	21
Steam pressure at exhaust, lb. per sq. in. abs.	15.1
Speed of pump, r. p. m.	386
Pump discharge, gal. per min.	33,300
Total head on pump, ft.	37.63
Steam consumption, lb. per hour corrected to 150 deg. fahr. superheat	10,860
CAPACITY TEST[2]	
Speed of pump, r. p. m.	382
Pump discharge, gal. per min.	51,800
Total head on pump, ft.	20.60

[1] Test made with discharge valve adjusted to give approximately normal operating head.

[2] Test made with discharge valve wide open.

TABLE 4 SUMMARY OF CONDENSATE-PUMP TEST

Duration of test, hours	1
Barometer, at 58.1 deg. fahr.	29.73
Steam pressure at throttle, lb. per sq. in. abs.	216
Superheat at throttle, deg. fahr.	28
Steam pressure at exhaust, lb. per sq. in. abs.	15.2
Speed of pump, r. p. m.	1495
Pump discharge, lb. per hour	475,000
Suction head, in. Hg	26.2
Discharge head, ft.	60.9
Total head on pump, ft.	90.64
Steam consumption, lb. per hour corrected to 150 deg. fahr. superheat	1840

Fig. 6 shows the variation of steam pressure with the load at various points throughout the turbine. In order to correct the steam consumption to the standard conditions, the curves given in Fig. 7 were used.

WATER-RATE FACTOR

In order to make an absolute and numerical comparison of the flatness of water-rate curves for different turbines, an expression has been used which is termed the "water-rate factor." Expressed mathematically,

(Continued on page 460)

The Necessity for Improvement in the Design and Operation of Present-Day Locomotives

By H. W. SNYDER,[1] LIMA, OHIO

In view of the demands of constantly growing passenger and freight traffic, the most urgent problems confronting locomotive designers and operating officials are, in the opinion of the author, those of increasing the capacity and efficiency of the present-day locomotives. As the limit of size of cylinders and of boilers due to road clearances has practically been reached, it is evident that any increase in the hauling capacity of a locomotive without increasing its size must come about through the employment of special devices. The superheater, brick arch, and mechanical stoker have all shown their desirability in this respect. Two other devices yet to be adopted in this country are the feedwater heater and the variable exhaust, both of which have given satisfaction in Europe.

After a brief discussion of engine problems, the paper proceeds to the consideration of the design of main and side rods and crankpins to withstand the tremendous piston thrust to which they are subjected in large engines; the difficult problem of counterbalancing; frame design and cross-bracing; driving-box brasses; means for temporarily increasing tractive power on critical grades and for starting heavy loads; ash-pan design; and lubrication.

In conclusion, it is stated that the present need is to apply the many labor-saving and capacity-increasing devices which have already been worked out and are giving satisfactory service, and at the same time look forward to the possibilities of applying other devices which have already proved that they are well worth consideration and are of sufficient importance to warrant their adoption.

NO one, it is believed, will dispute the fact that present-day operation of high-power locomotives is one of the most vital questions with which our railroads are concerned. The demands of constantly increasing passenger and freight traffic have brought about a constant increase in size and power of our locomotives.

It has not been so many years since an engine of 25,000 or 35,000 lb. tractive power was sufficient to take care of all requirements. Twenty years ago cylinders 22 or 23 in. in diameter were considered as about the limit in size. Constantly increasing demands on motive power since that time have brought us to the huge Mallet engines with tractive powers of from approximately 150,000 to 175-000 lb. Our simple engines have increased from 20-in. or 21-in. diameter cylinders up to 31-in. cylinders, with a tractive power ranging from around 35,000 lb. to 83,000 lb. In view of the rapid strides that have taken place in increasing the size and power of locomotives within the last few years, it seems rather out of place to predict that the maximum has been reached. It is also true that the use of improved devices has made possible the satisfactory operation of the large locomotives of today. Everything seems to indicate that we have not reached the maximum capacity of the locomotive even within the present limits of clearance and rail load, and we may expect to see these same engines made far more powerful and economical by the application of devices which are now available or which are already being given serious attention.

In view of the foregoing, the most vital matter which confronts locomotive designers and operating officials is that of increasing the capacity as well as the efficiency of the locomotives which we have today, and in the following paragraphs an attempt will be made to draw attention to some of the problems involved and upon the proper solution of which depends their success.

Combustion and Steam Generation

In order that large engines may operate properly, it is of course necessary that a sufficient supply of steam be furnished to cylinders so that they can be made to produce their maximum horsepower. It is not enough to provide a given number of square feet of heating surface in the firebox and the tubes—it is necessary that we take into account proper construction of the boiler, necessary firebox volume to produce the best possible combustion of fuel, and the design of grates so that fuel will be economically burned to such an extent only as required by the maximum evaporation of the boiler.

In producing heavy motive power it has been necessary on account of prohibitive axle loads to apply a sufficient number of axles under the engine to reduce the individual axle load to within reasonable limitations. This has lengthened out the engine to such an extent that boiler design and maintenance have become a serious problem. In the first place it is necessary to design a boiler that will properly function with the other vital parts of a locomotive. At the same time the length has become such that the use of combustion chambers is a necessity to avoid a prohibitive length of tube. Large engines have been constructed with a tube length of 25 ft. and it seems that no definite rule has been established as to what the limit of length of tube of a given size should be. Tubes 2 or $2^1/_4$ in. in diameter in excess of 20 ft. in length however, are questionable, and this feature should be looked into carefully before a decision is reached.

The application of a long combustion chamber requires a large number of additional staybolts, and it would naturally be expected that a boiler of this kind would require more staybolt attention. Complete as well as partial installation of flexible staybolts has met with varying degrees of success on many railroads, but the consensus of opinion seems to be that their application goes a long way toward overcoming staybolt trouble. It has been proved by experiment that if flexible stays are properly applied to the boiler when built, while they may make a slight movement during the firing up of the locomotive, after the boiler has become completely heated and steam pressure raised these stays assume their original position. Although long combustion chambers require more attention in maintenance, this will be offset by the increased firebox volume and the resulting better combustion.

On account of height limitations, the height of the dome as well as the steam space in the boiler has been reduced to such an extent that difficulties are being encountered with the proper life and maintenance of superheater equipment, because too much water is drawn over through the throttle into the superheater. This is a question requiring experiment to determine as nearly as possible the minimum steam space which should be provided for boilers working on various grades. The height of the dome has a great deal to do with obtaining dry steam, and in the opinion of the author consideration should also be given to the height of the throttle above the water line as well as to the steam space in the boiler. Considerable development on this subject is now well under way and we can confidently expect results of value in the near future.

We have about reached the limit of size of cylinders and size of boiler due to road clearances, and to undertake to provide additional road clearance on practically all of the main lines today would mean a total expenditure of money entirely out of proportion to the benefits that would accrue.

On account of the apparent limitations of piston thrust and road clearances, the greatest problem we have with our large locomotives today is to increase their capacity without exceeding greatly our present sizes. Anything to increase the hauling capacity of the locomotive without increasing the height and width limitations under which the locomotive must work might be called an essential capacity-increasing device. A few of these with which we are most familiar and which have proved beyond doubt their desirability are the superheater, the brick arch and the mechanical stoker. There are possibilities of still further increasing the efficiency of the superheater without increasing the size of the boiler in which it must operate. There are also possibilities and constant improvements in the design of brick arches which lend to higher evaporation and better combustion of fuel. It has been stated that when a locomotive requires as much as 6000 lb. of coal per

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hour it has gone beyond the limits of the ordinary fireman. Automatic stokers have been in use so long that their dependability for heavy power is no longer in question. Many men are studying this particular feature of locomotive design and operation, and we may confidently expect in the future a gradual increase in the efficiency of these mechanisms.

It has been proved without a doubt in foreign countries that the feedwater heater is an essential capacity-increasing device as well as an economical addition to the locomotive. In Germany they apparently do not now consider producing large locomotives without this device. In this respect, then, it would seem that we are somewhat behind the Europeans, and there is no doubt that in the near future when the economies that can be effected by its use are realized it will become almost as general as the superheater today.

Another small item which has received only passing attention in this country is the variable exhaust. As is well known, a variable exhaust that can be properly operated and which will not require much maintenance attention will have a great tendency to relieve high back pressure at high speeds, and its operation will also provide the necessary draft at slow speeds. European locomotives in a great many cases are equipped with such a device which seems to give satisfaction.

The Engine Proper

There have been no radical changes in the general design of cylinders. The use of outside steam pipes has resulted in advantages both from a casting and maintenance standpoint. It would seem well worth while to consider a design of cylinder by means of which the weight could be reduced to a great extent, permitting of additional weight of other parts and thereby increasing the capacity of the locomotive.

The design of valve gears has received a great amount of attention and many accepted types are now available. In all of these every effort has been to better the steam distribution. In maintenance we are far ahead of engines used twenty years ago. There is yet, however, much to be desired in steam distribution, and this subject will bear as careful study in the future as it has in the past.

Power Transmission

When we consider that as much as 150,000 lb. piston thrust is being transferred through a single main rod and from this into the driving wheels of a locomotive, it is not difficult to understand why troubles are experienced with main crankpins and particularly side-rod bearings at the main pin. In order to provide the proper strength to take care of this tremendous thrust, it has been necessary to design extremely heavy main and side rods. Further, the inertia forces, particularly in drifting, at times reach figures that are even greater than the piston thrust. Practically all of this must be taken care of through the main crankpin and the necessary connections to the side rods at this point.

All are familiar with the efforts made to produce a steel that would give a higher elastic limit than the ordinary high-carbon open-hearth steel successfully used until engines reached their present proportions. The employment of such steel for side rods, main rods and piston rods has been principally confined to heat-treated and quenched forgings, which are considerably lighter in section than when the ordinary open-hearth annealed forgings were used. Steel has also been produced which gives a high elastic limit and which can be successfully used with ordinary annealing. The use of such a steel does away with quenched forgings and permits of rods being heated for closing in straps and similar work without destroying the quality of the material as is the case with quenched forgings.

Main and side rods have been produced and have been in successful operation for the past few years in which the piston thrust is carried directly from the main rods to the side rods back of the main wheel. This does not in any way reduce the piston thrust that must necessarily come on the main rods. At the same time, however, it does reduce very considerably the piston thrust that must be transferred through the main crankpin into the side rods, thereby alleviating to a very great extent the troubles that have been experienced with large side-rod connections at the main pin. Such a design does not increase the total weight of the rods to an extent likely to cause any appreciable increase in difficulties from a counterbalance standpoint.

It is impossible to take into account all the stresses produced in rods when a locomotive is in operation, and for this reason the allowable fiber stresses in tension, compression and bending must be small in comparison with the elastic limit ordinarily obtained in such forgings.

Rod design is a study in itself and presents a subject the details of which cannot be covered in a paper of this nature. Hollow-bored piston rods, light designs of crosshead and piston, the use of high-tension steel for side and main rods, as well as the use of hollow-bored crankpins, are familiar to all. More careful attention should be paid to the quality and upkeep of rod bearings, and every endeavor should be made to provide bearings of such quality and design that renewals will be reduced to a minimum.

Before the advent of our present-day large locomotives with their tremendous piston thrust it was not a particularly difficult matter to design a suitable main crankpin. In order for it to be of sufficient size to withstand heavier piston thrust and still maintain the fiber stress within workable limits, it was found necessary to increase the diameter proportionately. This brought up the question of rubbing speed. It is a well-known fact that if the rubbing speed is too high, bearings will heat and wear very rapidly regardless of the bearing pressure. A main pin designed properly for heavy piston thrust must therefore be so proportioned that the length will bear a certain relation to the diameter within very close limits. On account of the necessity for keeping cylinder centers as close together as possible because of road clearances, if a proper length of main pin is obtained, its proper size presents a difficult proposition. This is one of the great difficulties which the author is confident will be overcome in the future by the proper application of a design previously mentioned, wherein a large part of the piston thrust is transmitted directly from the main rod into the side rod, thus reducing the force that previously has been taken through the comparatively short and large-diameter main side pin.

Counterbalance

There is a great diversity of opinion in regard to the proper amount of counterbalance which should be applied to locomotives. We ordinarily think of a locomotive being counterbalanced properly when it will ride satisfactorily and without excessive vibration, and it seems that this is the rule by which counterbalance is judged. There are in operation heavy Santa Fe type locomotives which have between 35 and 40 per cent of the reciprocating weights counterbalanced, and they are said by traveling engineers to ride easy. The author believes that with our present heavy engines with long wheelbase it is not necessary to balance as much as 50 or 55 per cent of the reciprocating weight. In fact, it is quite possible that we may be able to counterbalance a smaller percentage of reciprocating weight than has heretofore been attempted, especially for long, heavy engines, provided the revolving weights at the main pin can be properly taken care of. Every effort, however, should be made to balance all of the revolving weights on the main pin. If, for example, we lack 400 lb. of balancing the revolving weight on the main pin, the effect on the track is exactly the same as if we had 400 lb. of counterweight on any of the other wheels to balance reciprocating parts.

On account of the extremely heavy weight required at the main pin in order to have the proper strength of parts, particularly for large freight locomotives, it is a difficult matter to balance very much—if any—more than the revolving weights at this point. This being the case, if as much as 50 or 55 per cent of the reciprocating weights is to be balanced, it is easily seen that all of the counterweight for reciprocating parts must be added to the counterweight in the wheels other than the main. Thus, in order to balance a high percentage of reciprocating weights on engines of this class, it is necessary to add counterweight to the wheels other than the main to such an extent that track stresses and riding of the locomotive at comparatively high speeds become a very serious question.

The author is of the opinion that no definite set rule can be established in this regard, but that each particular design is a study in itself, and wherever revolving weights at the main pin are encountered such that they cannot be properly counterbalanced,

steps should be taken to provide the best means possible of reducing revolving weights at this point as well as providing reciprocating parts as light as possible consistent with strength. This of course has been accomplished in the past by hollow-boring the main pins and piston rods and by using a light design of piston head, which indicates that a steel having a high elastic limit with the proper elongation and reduction of area should be employed.

The Running Gear

On account of the large increase in the size of cylinders of present-day heavy locomotives over those used several years ago, the cylinder centers have been spread until they have reached practically the clearance limitations of the railroads; and the necessity for larger journals to carry properly the increased axle loads has caused the frame centers to be brought nearer together.

This condition increases very materially the distance from the center of the cylinder to the center of the frame, which of itself produces greater strain in the frame and at the same time increased pressures on the driving-box bearings as well as on shoes and wedges. In addition to the above, piston thrusts have increased from approximately 65,000 lb. to approximately 150,000 lb., and means must be provided to properly take care of the increased piston thrust along with the increased overhang.

Fig. 1, it is believed, shows very clearly the increased forces that a frame must stand in order to properly take care of the tremendous increases in piston thrust as well as the increased leverage caused by the very considerable lengthening of the distance between the cylinder centers and the frame centers.

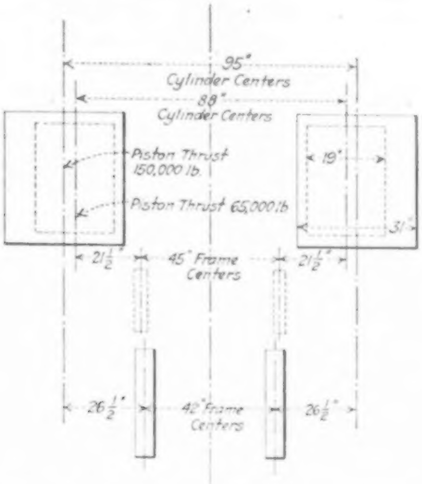

Fig. 1 Diagram Showing Increase of Overhang of Cylinders in Present-Day Locomotives

Substantial and sufficient cross-braces should be applied between the frames and rigidly bolted thereto to form a rugged structure which will not rattle to pieces. Sufficient bearing for bolts and adequate bolting flanges are a very important feature. At the same time it must be borne in mind that there is a possibility of tying up the frame so rigidly that there will be a tendency for failures ahead of the front pedestal and just back of the cylinder fit at a point where it is practically impossible to obtain sufficient reinforcement.

It seems as though the design of driving boxes and driving-box brasses had not successfully kept pace with the rapid increase in piston thrust. It is very evident that we shall have trouble in taking care of driving-box brasses until a suitable design is produced—one in which the brass will cover much more of the front and back projected area of the journal than is now the case. Many experiments have been tried, and in many cases they have gone beyond the experimental stage and have proved to be very satisfactory. Among these are driving-box brasses cast into the driving box. Many boxes are in use today where the brasses are keyed into the box, making them readily removable for replacement. However, the author feels that none of these has approached the solution to the problem, which lies in producing a design that will surround the journal with a bearing as completely as possible and still lend itself to comparatively easy maintenance and reasonable cost of application.

Guiding and Trailing Trucks in Connection with Long Wheelbase

Santa Fe type engines with 22-ft. rigid wheelbase are not uncommon. Engines of this type and of this size will weigh in the neighborhood of 400,000 to 420,000 lb. When we stop to think that to move this tremendous mass of material around a 16- or 18-deg. curve a force of many thousands of pounds is required, is it any wonder that we obtain rapid flange wear and the necessity for returning tires before the proper amount of mileage has been obtained? In the majority of cases, it is believed, the force necessary to properly curve an engine of this kind has been applied at the front truck and the first driver. In most cases types of leading trucks have been used which produce a very small resistance on curves of small degree. In order to prevent rapid flange wear as well as to overcome the development of lateral play unnecessarily, designs have been produced which will give a high initial resistance of the front truck and provide a lateral motion for the front driver with adequate resistance so that some of the guiding force is transferred back to the second pair of drivers.

Since locomotives operate the greater part of the time on tangent track, it is necessary to have a high initial guiding resistance which will not be increased when curving. In other words, a flexible wheelbase is produced which has all the requisites of the ordinary rigid wheelbase, but at the same time will overcome many of the difficulties now encountered in an attempt to operate engines of this size and length. Many designs of trailing trucks have been produced with the idea in mind of helping to remedy the conditions which have been noted above. These of course have met in a way the conditions which it was necessary to overcome. What is needed is a positive centering device whose resistance will be adequate initially, can be always depended upon, and which will not mount up to prohibitive figures under the maximum swing of the trailing truck.

In addition to the foregoing, some work has been done in the way of producing a design by means of which the lateral play in locomotive driving wheels can be taken up without removing the wheels from under the engine or taking the boxes off from the axles.

The advent some years ago of the power reverse gear overcame one of the great objections that engineers had too large locomotives. It is a fact that it is almost impossible for one man to reverse one of our large locomotives equipped with the ordinary hand reverse lever. Power reverse has come to be an essential part of engine equipment and has been found to be economical even though it may be used on a locomotive which could be comparatively easily reversed by hand.

Probably no one thing contributes more to the failure of side rods than the improper adjustment of shoes and wedges. If these are allowed to run loose, stresses in the side rods will amount to a very high figure, and if they are improperly set up, the driving wheels are very likely to be out of tram. This in itself brings undue stresses on the rods, which in time will unquestionably produce failures. The author feels that there are many cases where in attempting to overcome the failure of side rods we have deliberately increased their sections without giving due consideration to the cause of failure. Consideration of the foregoing brings us to the point of providing an adequate automatic adjustment of the wedge so that the difficulties mentioned will not be encountered.

Means for Increasing Nominal Tractive Power

All railroads have points on certain divisions where there is a critical grade or the necessity of starting a heavy load under adverse conditions. At such places increased tractive power is required which is not needed elsewhere. We are therefore confronted with the problem of producing a device which can be set to work to increase the tractive power of a locomotive in such cases, thus enabling the engine to take its full tonnage over the entire division. This device should be so made that it can be applied when necessary and thrown out when the additional tractive power is not required. Designs have already been produced wherein an additional tractive power of 8,000 or 10,000 lb. has been applied to the trailing trucks of large locomotives. There is also a possibility of applying such a device to the tender truck, thus availing

ourselves of the adhesive weight of the tender to help boost the engine over the critical points in a division. There is always present a possible potential boiler capacity which can be brought out by the use of a variable exhaust or other device sufficient to obtain rapid combustion at slow speeds.

The Ash Pan

The question of ash pans is also one needing serious consideration. There are in use a number of rules stating what the proper air opening in the ash pan should be, and while many of these rules have in a way proved satisfactory, it would nevertheless seem that to get at the question logically we should determine the amount of coal that can be burned economically per square foot of grate and then on this basis provide an ash-pan air opening that will give the required amount of air to burn satisfactorily the maximum amount of coal which is expected to be consumed. The amount of air that will flow through a given opening in the ash pan, it is believed, can be very closely approximated from the vacuum produced in the smokebox. This of course is only a suggestion, and it may be that when the question is looked into more carefully a more desirable and accurate method of determining the required ash-pan air opening may present itself.

Lubrication

With our present high superheat the proper introduction of oil into the cylinders and valves of a locomotive is worth serious consideration. In many cases oil has been provided to both the cylinder barrel and the steam chest of superheater locomotive, and in other cases it has been provided to the steam chest alone. Both methods have given apparent satisfaction, but it is a difficult matter to state which is the better.

It is common practice in European countries to provide a force-feed lubricator located very close to the cylinder, with a pipe to each end of the piston-valve steam chest. This oil supply opens directly over each end of the valve when it is in central position. In addition an oil pipe is supplied to the cylinder at its center. It is reported that by this method there is less carbonization of the oil than when it is fed into the steam pipes or into the center of the piston-valve steam chest.

In order to increase the tonnage which a locomotive can haul it is just as vital to decrease the resistance as to increase the power. Now it is not an impossibility to provide roller bearings for passenger cars, and there seems to be no reason why they cannot be used on freight cars. The reduction of rolling resistance and the better facilities for lubrication which would be provided would be sufficient in time to overcome the necessary expense.

This question of lubrication may as well apply to other parts of the locomotive. The proper grooving of side-rod and main-rod brasses, or the use of babbitt inserts, are questions that should be taken up in connection with lubrication of these parts.

Conclusion

In summing up the situation, it may be said that the use of the superheater alone has increased the capacity of locomotives when compared with saturated engines of the same design to such an extent that no one would think of building a large locomotive for up-to-date railroad service without the application of superheat. We must not content ourselves, however, with what has been done with this one device. What we need to do now is to avail ourselves of the opportunities offered in the application of many of the labor-saving and capacity-increasing devices which have already been worked out and are giving satisfactory service, and at the same time look forward to the possibilities of applying other devices which are yet in their infancy, but which have proved beyond doubt that they are well worth our consideration and are of sufficient importance to warrant their adoption. Without the capacity-increasing devices which have been mentioned the large locomotive of today would be impossible—it could not be operated satisfactorily. Our large engines are an absolute justification of these improvements. Further developments are ready at hand and in their use lie the possibilities of still more powerful and economical transportation units built to operate within our present limitations of clearance and permissible rail loads.

MID-WEST CENTRAL-STATION POWER

(Continued from page 444)

the highest tension in the Middle West—with some distribution at 70,000 volts.

In Wisconsin the important hydroelectric developments on the lower Wisconsin River at Kilbourn and at Prairie du Sac are connec'ed by 66,000-volt lines to Milwaukee and to important manufacturing centers to the south, which are included in the Middle West system. The water powers of the Chippewa River and its tributaries have been developed largely by the Brewer interests. Much of this power goes to St. Paul and Minneapolis over a 120-000-volt line, and to other Mississippi River cities farther south. The distribution to the south and west from St. Paul and Minneapolis is over 66,000-volt lines and 110,000-volt lines owned by the Byllesby Company.

A study of the five principal states of the group represented in Fig. 2 indicates that when power is to be generated by steam it can best be done by central stations in the locality where it is to be used. For example, Chicago, with its large and efficient power houses, is surrounded by power houses of the Public Service Company of Northern Illinois and by those of the Middle West Utilities Company, with all of which it exchanges power, but which nevertheless generally supply the power needed in their immediate respective vicinities. Chicago is connected with Keokuk and Keokuk with Indianapolis and New Albany, and yet the power sent over these lines from its large power houses is small in comparison with that generated and distributed locally along the lines.

Formerly each small country town requiring 50 kw. or more had its own central station, using 20 lb. of coal per kw-hr. As there was no money in that, there came about consolidations of these isolated central stations into small groups, all supplied from the best-located plant of the group. It was found that with an improved load factor and larger units the coal consumption was by this means reduced to 15 lb. per kw-hr. The next step was to connect these groups into larger ones of 5000 kw. capacity, favorably located as regards condensing water and rail connections, having condensing turbines and capable of delivering a unit of energy for 4 lb. of coal. A plant of this size can reach out its arms and gather in all of the power within a radius of thirty miles or so. This is about the most efficient combination of station power and transmission lines, unless it happens that the power demands of the city in which the plant is located are such that the use of generating units up to 15,000 kw. is practicable, in which case a further material improvement in efficiency is secured and warranting the construction of longer lines to reach more remote groups of power, these large plants being interconnected over lines of sufficient capacity to permit them to be mutually helpful.

Such is the plan which is naturally developing, and although its progress must be as slow as the process of consolidation of the properties, it appears that the problem of cheaper power production is working out its own solution along conservative lines and that in time the present systems will merge into larger ones, with one general scheme for generation and distribution, so that areas equal to a state in extent and overlapping state lines shall be under one management.

What, then, about home rule? Many years ago, when "tariff" was the football of national politics, a candidate for the presidency, upon being asked to declare his position on this burning issue, replied that the tariff was a local question and had no place in a presidential campaign. It is by such reasoning that the interests of a utility, stretching for hundreds of miles across the country and supplying power to hundreds of scattered or contiguous communities and to thousands of industries, becomes a local question and properly subject to local regulation as a foreign monopoly by each of the various cities, towns and villages in which it renders service.

Fortunately it is becoming generally recognized that a state-wide industry of this character requires state-wide regulation andt hat for the state to abdicate its jurisdiction, cut it up into sections and parcel out the pieces to the police powers of the various localities in which the utility operates, subjecting it to the vicissitudes of local politics, cannot help that utility to develop and to most economically and efficiently serve those same communities.

Advantages of Large Freight Locomotives, Particularly the 2-10-2 Type

By ALBERT F. STUEBING,[1] NEW YORK, N. Y.

In this paper the author points out the more important considerations involved in a study of the economic value of various types of motive power and demonstrates the complexity of the problem. Probably, he holds, no absolutely correct analysis is possible, and surely no practicable. The choice of motive power is of extreme importance because the characteristics of the power affect the earnings more than any other single factor and determine the efficiency of operation usually throughout the life of the engine. For this reason the choice of the locomotive should be made with extreme care. The final decision should be based on a definite knowledge of the economies that can be realized, not on unsupported opinion. Engineering methods are essential in working out the solution, and the study of the problem offers a field for constructive coöperative work by the members of the engineering societies.

PROBABLY the briefest presentation of the advantages of large locomotives is that made by James J. Hill: "Receipts are by the ton- and passenger-mile; expenses are by the train-mile." It is not to be expected that such a general statement will hold good in all particulars, nevertheless it is true that a large proportion of operating expenses decrease as the train load increases, although not in the same proportion as the decrease in train-miles. Under the operating conditions existing on most of the main-line mileage of this country, the greatest possibilities for economy are probably still to be found in the adoption of locomotives of high capacity.

The large locomotive, designed merely for high rated tractive effort, is not a panacea for operating troubles. The first requisite is a design suited to the conditions of the operating territory, the traffic, and the service. The relative advantages of specific designs are a problem in the economics of operation that must be solved by the application of engineering principles. It is a question of adapting the design to the operating and economic conditions and then coördinating the motive power with other facilities.

The adoption of improved power should be only one part of a coördinated program. Every appropriation for larger engines should carry with it, as an integral part, provision for facilities to insure the maximum utilization of the power. Engine terminals, shops, yards, the rolling stock and the track structure itself should be prepared to assist in obtaining the proper operating results. The coördination of facilities deserves careful study. Much better results will be obtained by the use of locomotives adapted to existing conditions where the related facilities cannot be adapted to the locomotive.

The choice of motive power is of extreme importance because the characteristics of the power affect the earnings more than any other single factor and determine the efficiency of operation usually throughout the life of the engine. The problem of introducing new locomotives is similar to the problem of reducing grades and should be studied as thoroughly. The interrelation between the various factors affected affords large opportunities for savings and also for losses. Many investigations have been held up during the past few years and the rapid changes in prices have made earlier data inapplicable. It would seem, therefore, that there is a large field for research in the economic problems of operation when normal conditions are restored.

Most of the available reports on the economic value of heavy locomotives consider comparatively few of the items affected. The comparative costs of wages of train crews, of fuel and water, and of repairs to locomotives are often the only items considered. In some few cases the comparative mileage and fixed charges on the investment in motive power have been computed. This is not sufficient to determine conclusively the relative merits of various types of power. The locomotive has a direct or indirect influence on many items of expense in the maintenance of way, maintenance of equipment, and transportation accounts. The real problem in determining the value of a locomotive is to find the effect that its operation will have on the sum total of these accounts, and the results of a thorough study should more than justify the labor involved.

It is the purpose of the following paragraphs to point out some aspects of the problem that apparently are deserving of attention. A search through the literature on this subject has failed to disclose fundamental data on these questions that are applicable to present conditions.

The Effect of Motive Power of Maintenance-of-Way Expenses

Some roads have reached adverse decisions on the adoption of 2-10-2 type locomotives on the ground that the increased cost of roadway maintenance resulting from their use would more than offset the savings in wages. Maintenance-of-way expenses make up about 17 per cent of the total operating expenses, but the greater part of the expenditures are independent of the character of the power. Much of the work of track maintenance is made necessary by the action of the elements, or by the necessity of maintaining the permanent way in suitable condition for fast passenger traffic. The expense which is most directly affected by heavy locomotives with long, rigid wheelbases is rail renewals. Other accounts that are affected to a lesser degree are ties, track laying and surfacing, roadway maintenance, and superintendence.

There is little or no information available as to the comparative effect of four and five pairs of coupled wheels on rail wear and the other accounts affected. The actual effect will vary according to the wheelbase, the curvature of the road, and whether the locomotive has one or more pairs of drivers equipped with lateral-motion devices.

The sum of the maintenance-of-way expenses which may be increased by heavy motive power is about 10 per cent of the total operating expenses, and if the effect is to increase these items considerably the saving will be difficult to make up in other accounts. However, if the wear and tear on the track is merely proportional to the weight of the engine, as is sometimes assumed, light and heavy engines would be on a par as regards these items. The difference of opinion on this question suggests the necessity for a careful investigation.

Maintenance of Equipment

The percentage of the total operating expenses falling in this classification has shown a fairly consistent increase over a considerable period. Locomotive repairs and renewals, which in 1898 amounted to 5.9 per cent, in 1918 had increased to 11.7 per cent. So many factors may influence this ratio that no definite conclusions can be drawn, but it is significant nevertheless.

The principal difficulties in maintaining large locomotives are due to the short life of driving-wheel tires, driving boxes and main-pin bearings. With the proper facilities and proper construction the work of caring for these parts becomes merely a matter of routine running repairs, but where the lack or inadequacy of terminal facilities hampers repairs, the loss of service due to these minor items may become serious.

While the foregoing remarks are confined to some of the more important items of roundhouse maintenance, they are equally applicable to the work of classified repairs. If the shops and shop machinery are not adequate for new power, repair charges will be high and the time out of service will be increased. The cost of these facilities should be considered when estimating the saving that may be effected by new power.

Wide differences of opinion appear to exist regarding the relative cost of maintenance and mileage of 2-10-2 type and Mallet loco-

[1]Associate Editor, *Railway Age*. Jun. Am.Soc.M.E.

Abstract of paper presented at the Spring Meeting, Chicago, May 23 to 26, 1921, of The American Society of Mechanical Engineers. All papers are subject to revision.

motives. While the field for each is to a certain extent distinct, there are districts where either might be suitable and roads that have sufficient data to permit a fair comparison could perform a service by furnishing information that would clear up this question.

A very serious problem in connection with the use of locomotives of high capacity is the effect on the cost of repairs to freight cars. The total amount spent for repairs and renewals is nearly as great as the repairs and renewals to freight and passenger locomotives combined. When the length of trains is increased beyond a certain point, break-in-twos, shifted loads, and damage to the cars in general may increase at a rapid rate. The effect of increasing the length of the train may be serious where the road cannot control the character of equipment in the trains, where the car load is light, the train long, and the lading is subject to damage or of such a nature that it may shift and damage the car. It is significant to note that a study made by N. D. Ballantine showed the time delayed due to car failures was more than twice as great with a Mikado engine, which had a tractive effort of 57,000 lb., as with a Consolidation of 39,000 lb. tractive effort.

A study of car failures in long trains may demonstrate that the trouble is largely due to equipment with weak underframes. If wooden underframes are a serious hindrance to the operation of long trains, the remedy can be applied with little difficulty. While the reinforcement of the remaining cars of this type still in service would require fairly heavy expenditures, it would no doubt be justified by the saving in repair costs and improved operation.

Transportation Expenses

Directly or indirectly, the locomotive affects items in the transportation expenses which amount to about 35 per cent of the total operating expenses. Two of the important items which are reduced almost proportionately as the tractive effort increases are wages of train enginemen and trainmen. The economies in these expenses are considerable and they can be predetermined with a fair degree of accuracy.

Enginehouse expenses likewise are affected by the character of the power to an extent depending on local conditions. The reduction in the number of units handled will probably cause a slight decrease in the cost per ton-mile unless the new equipment makes additional facilities necessary.

Several miscellaneous items of operating expenses are also affected to some degree, such as accounts affected by collisions and derailments, loss and damage, damage to live stock, clearing wrecks and injuries to persons. The effect of car failures on loss and damage has already been mentioned. In so far as these expenses are due to collisions and derailments, they are increased by an increase in train density rather than by an increase in the length of the train, and would therefore be reduced by the use of locomotives of high capacity.

Fixed Charges

The fixed charges on the motive power seldom exceed three to four per cent of the operating expenses. The difference between the fixed charges on a thoroughly efficient modern engine and a crude design that might be bought to make an insufficient appropriation cover a given number of locomotives, is negligible. However, the difference in the earning power of these two types is quite appreciable and serves to show what large returns can be derived from the additional capital expended for refinements and accessories that give increased capacity and efficiency.

At first thought it might seem that the additional investment for terminals, shops, and shop machinery would add greatly to the capital expenditure and the fixed charges. Under ordinary conditions, however, the cost of roundhouse space required properly to house a locomotive is a comparatively small proportion of the cost of the power. The cost of the shop buildings and machinery is even less important when the added efficiency and decreased cost of repair operations are considered.

Sometimes the introduction of heavy locomotives necessitates strengthening or replacing bridges or laying heavier rail over certain sections. The expenditures involved are often quite large, but the relatively long life of these structures decreases the fixed charges and the additional cost per ton-mile becomes comparatively small and is seldom an important factor in determining the most economical equipment. When new rail must be laid the additional expenditure is a more serious item and the charge would probably not be justified except on a line with relatively dense traffic.

The preceding discussion pointing out the more important considerations involved in a study of the economic value of various types of motive power demonstrates the complexity of the problem. Probably no absolutely correct analysis is possible; surely, it is not practicable. The question is of extreme importance because the possibilities of economical operation are circumscribed by the motive power. For that reason the choice of the locomotive should be made with extreme care. The final decision should be based on a definite knowledge of the economies that can be realized, not on unsupported opinion. Engineering methods are essential in working out the solution and the study of the problem offers a field for constructive coöperative work by the members of the engineering societies.

EFFICIENCY TESTS OF A 30,000-KW. STEAM TURBINE

(Continued from page 454)

$$F = \frac{MW}{C}$$

in which F = water-rate factor; M = minimum water rate obtained; W = mean load between one-half rated load and maximum load, which is the usual operating range; and C = average total steam consumption per hour covering the range between one-half rated load and maximum load.

Using the curves given in Fig. 4, substitutions may be made as follows:

$$F = \frac{11.03 \times 25{,}000}{280{,}100} = 0.985$$

This factor could be expressed by using the ratio between the minimum water rate and the average water rate over the range selected. However, the factor obtained in this manner would not take into account the fact that it is more desirable to obtain flatness in water-rate curves at the high loads than it is at the low loads. By using the total steam consumption as indicated in the expression given above, a fairer comparison is obtained.

Condenser and Auxiliary Tests

Tests were conducted on the condensers and auxiliaries. A summary of the condenser and dry-vacuum-pump tests, which were run simultaneously, is given in Table 2, while the relation between load and vacuum is shown graphically in Fig. 8. In examining the results of these tests and comparing them with the vacuum obtained during the turbine tests, it should be kept in mind that the temperature of the circulating water during the condenser tests, which were run during the summer, was very high, varying from 75.1 deg. fahr. to 78.2 deg. fahr. The methods used in determining the quantities given in Table 2 need no description, with the possible exception of the measurement of the air discharged from the dry-vacuum pump and the steam consumption. The air was measured by a gasometer connected to the discharge of the pump. The steam consumption was determined by condensing the exhaust steam in a small test condenser, after which it was weighed in the usual manner.

Table 3 gives the results of the tests on the circulating-water pump. It will be seen that two tests were conducted on these pumps, one being an economy test while the other was a maximum-capacity test. Only one of the two pumps was running in either test. During the economy test the discharge valve was adjusted to give the normal operating head which exists when two pumps are running, while in the capacity test it was left wide open. The quantity of water pumped was computed by the heat-balance method, which involved the measurement of the main-turbine condensate, its temperature, the temperature of the circulating water in and out, the steam conditions at the main-turbine throttle, load on main unit, etc. The steam consumption of the turbine driving the pump was determined by means of the small test condenser mentioned above. The results of the condensate pump test are given in Table 4.

Chicago Meeting of A.S.M.E. Sets New Standard

Excellent Technical Program Vies with Attractive Excursions and Delightful Entertainments in Largest Spring Gathering

DRAWN by the strong technical sessions, interesting social events and instructive plant visits listed on the program, 1235 members and guests of The American Society of Mechanical Engineers registered for the Spring Meeting at the Congress Hotel, Chicago, May 23 to 26. The attendance exceeded that of any previous Spring Meeting, but the large number was but one of the attributes of a successful meeting. The Chicago General Committee had worked hard in the planning of the event and their labors were rewarded by the pleasure of seeing a smoothly conducted affair. The program was full—fourteen sessions, numerous committee meetings and plant visits—but the schedule was rigidly followed and everything was completed in time.

The opening morning of the meeting was devoted to the Council Meeting and registration—the business session commencing at 2.30 in the afternoon, and the following mornings were devoted to professional sessions, the afternoons being reserved exclusively for plant visits. Tuesday evening was assigned to the session on Training in the Industries.

Entertainments

On Monday evening an informal reception was held in the Gold Room of the Congress Hotel. The Chairman of the Chicago Section and the President of the Western Society of Engineers with the officers of the Society greeted those attending the convention. A large number of Chicago members were on hand to assist in making the guests feel at home. The result was a right enjoyable evening.

On Wednesday evening an informal dance was held. The Gold Room was effectively decorated with flags and lights for an affair that was thoroughly appreciated from the first crash of an exceedingly competent jazz band. The floor was crowded and remained so during the evening, except for some few of the elders who drifted out into the corridors for a good chat.

Special attention was accorded the ladies at the Spring Meeting. Tours to the Marshall Field store and the Field Museum were conducted, and on Wednesday, following an automobile ride through the lake-front residential section of Chicago, they were guests at a charming reception at the home of Mrs. Robert W. Hunt.

Plant Visits

Chicago and its remarkable industrial surroundings furnished a fine opportunity for interesting plant visits. The Chicago Committee chose outstanding plants for these excursions and planned the details carefully, with the result that every one of them was faultlessly conducted. A definite number of visitors were assigned to each excursion and in every case the allotment was more than taken up. The plants visited included the Fisk Street Station of the Commonwealth Edison Company; Sears, Roebuck & Company; Illinois Steel Company; Pennsylvania Terminal; Crane Company; Mandel Brothers; Chicago Mill and Lumber Company; Western Electric Company; Pullman Company; Chicago Underwriters Laboratory, and the Yellow Cab Mfg. Company. The following plants were thrown open for inspection and many members availed themselves of this opportunity: Clementsen Company; Green Engineering Company; Hanna Engineering Works; Ilg Electric Ventilating Company; W. A. Jones Foundry & Machine Company; Link Belt Company, and the Joseph T. Ryerson & Sons Company. On Friday morning about seventy-five members visited the pulverized-fuel installation at the Lakeside plant of the Milwaukee Electric Railway and Light Company.

The Local Committee

The entire arrangement of the meeting was under the jurisdiction of the General Chicago Committee, made up of Robert W. Hunt, Honorary Chairman; Herbert S. Philbrick, Chairman; James D. Cunningham, Secretary; Melville S. Flinn, Treasurer; David Lofts, P. Albert Poppenhusen, Arthur L. Rice and Edward P. Rich. The enthusiastic and efficient work of this committee was responsible for a most successfully conducted meeting.

Proceedings of the Business Meeting

PRESIDENT Carman occupied the chair at this session. To promote discussion of a new Constitution, the first item scheduled at the Business Meeting was a paper by Morris Llewellyn Cooke entitled On the Organization of an Engineering Society. This paper was published in full in the May issue of Mechanical Engineering. By previous arrangement the discussion of the paper was placed in the Management Session the following day.

Members of the Chicago Local Committees Whose Enthusiastic Coöperation Contributed so Greatly to the Success of the Largest Spring Meeting yet Held

General Committee

Robert W. Hunt
Hon. Chairman
Herbert S. Philbrick
Chairman
James D. Cunningham
Secretary
Melville S. Flinn
Treasurer
David Lofts
P. Albert Poppenhusen
Arthur L. Rice
Edward P. Rich

Professional Events Committee

Herbert S. Philbrick
Chairman
John Calder
R. B. Hall
T. A. Marsh
Glenn D. Mitchell
H. M. Montgomery
Alexander W. Moseley
J. M. Spitzglass
Ralph W. Yardley
Coöperating in Plans for Chicago Session (Appointed by Western Society of Engineers):
J. R. Bibbins
F. K. Copeland
E. S. Nethercut
E. J. Noonan
A. L. Rice

Plant Visitation Committee

David Lofts
Chairman
William L. Abbott
George R. Brandon
Bert A. Gayman
Norman Lawrence
Warren C. MacFarlane
George E. Pfisterer
Nathaniel G. Symonds

Social Events Committee

P. Albert Poppenhusen
Chairman
Clayton O. Billow
Adolph G. Carlson
Horace Carpenter
Heinrich J. Freyn
George F. Gebhardt
J. J. Merrill
S. T. Nelson
Herbert S. Philbrick
Howard E. Troutman
Fred L. Webster
Frank R. Wheeler

Finance Committee

Edward P. Rich
Chairman
Oscar E. Andersen
Clayton O. Billow
Scott Bourne
R. T. Crane, Jr.
Courtney C. Douglas
Philip N. Engel
Philetus W. Gates
Arnold H. Goelz
Lorne A. Griffin
George M. Illges
Harold C. Jones
Daniel Lewy
James C. Matchett
P. Albert Poppenhusen
James V. Stannard
Frank F. Vater
J. D. Wallace

Program and Publicity Committee

Arthur L. Rice, *Chairman*
Frank G. Bolles
Robert I. Clegg
Edward C. DeWolfe
DeWitt C. Gross
Harry Himelblau
Walter Painter
Edward C. Pohlmann
Leon I. Thomas
Ralph E. Turner
Thomas Wilson

Hotels Committee

James D. Cunningham
Chairman
W. K. Abernethy
Horace Carpenter
A. Cole
Loren Hibbard
W. R. Macklind
O. R. McBride
A. H. McDougal
T. S. MacEwan
William J. Mohr
R. A. Widdicombe

Ladies Social Committee

Mrs. Robert W. Hunt
Hon. Chairman
Mrs. P. Albert Poppenhusen
Chairman
Mrs. Horace Carpenter
Mrs. James D. Cunningham
Mrs. David Lofts
Mrs. J. J. Merrill
Mrs. Herbert S. Philbrick
Mrs. Arthur L. Rice
Mrs. Edward P. Rich

Committee on Meetings and Program in General Charge of the Society's Convention

R. V. Wright
Chairman
A. L. DeLeeuw
W. G. Starkweather
J. W. Roe
L. B. McMillan

The President then introduced John L. Harrington, of Kansas City, Mo., Chairman of the Committee on Constitution and By-Laws, who presented the report of his committee.

Those participating in the discussion included Morris L. Cooke, S. N. Castle, Max Toltz, R. B. Wolf, D. S. Jacobus, P. F. Walker, Charles L. Newcomb, L. C. Marburg, R. L. Sackett, Fred Dorner, Roy V. Wright, W. H. Kenerson, D. S. Kimball, R. H. Fernald, George A. Orrok, L. B. McMillan, Messrs. Nelson, Case, and Jackson (Rock Island), L. P. Alford, R. T. Kent, Charles Penrose and Secretary Rice. The synopsis of their discussion will be published in the next issue in parallel with the Articles proposed.

Special Action on Juniors Voting

Morris L. Cooke, who has an amendment to the Constitution already pending to extend the privilege of voting to Junior Members, sought the sentiment of the meeting regarding this provision, and after considerable discussion the matter was put to vote and carried by a majority of one. This means that Mr. Cooke is entitled to again put his amendment at the Business Meeting next December, and the meeting will vote whether or not it should be submitted to letter-ballot of the membership next March.

Reports of Special Committees

The Standing Committee on Technical Nomenclature presented a progress report on Symbols in Heat Engineering. It was voted that this report be received and ordered printed in Mechanical Engineering for discussion.

The Special Committee on Standard Tonnage Basis for Refrigeration presented a report, already published in the January 1921 issue of Mechanical Engineering, defining the standard ton of refrigeration, the standard commercial ton and the rating of a refrigerating machine. The report was adopted.

The Joint Committee on Steel Roller Chains (with the Society of Automotive Engineers) presented standards for roller transmission chains and sprockets, which were adopted.

Fuel Session

Six papers were presented at the Fuel Session on Tuesday morning, namely: Recording Ash-Pit Loss from Chain-Grate Stokers, by E. G. Bailey; Boiler Tests with Pulverized Coal, by Henry Kreisinger and John Blizard; Limitations of Mechanical Stokers Utilizing Mid-West Coals, by E. H. Tenney; Capacity and Efficiency Limitations of Stokers Using Mid-West Coals, by John E. Wilson; Smoke and Its Relation to the General Health of the Community, by Dr. John Dill Robertson; and Latest Requirements of the City of Chicago in Furnace Design, with Special Reference to Hand-Fired Boilers and Limits of Each Design, by Frank Chambers. Joseph Harrington presided over the session.

The papers by Messrs. Kreisinger and Blizard and by Mr. Bailey were respectively printed in the May and June numbers of Mechanical Engineering; those by Messrs. Tenney and Wilson will appear in the August issue.

In the absence of Doctor Robertson, Commissioner of Health of Chicago, his assistant, Dr. Vernon Hill, spoke briefly on the importance of smoke-preventive measures in lowering the death rate from pneumonia and other acute respiratory diseases induced by the inhalation of dust-laden air. While admittedly an engineering problem, it had nevertheless been thought wisest in Chicago to entrust this work to the Department of Health.

Mr. Chambers' paper, which was read by R. H. Kuss, gave particulars of the requirements of the Chicago ordinance as regards fuel-burning equipment, together with data on draft losses through boilers, the rules employed in determining areas of stacks, height of furnace settings, etc.

Mr. Kreisinger supplemented his paper by particulars regarding the new Lakeside Plant of the Milwaukee Electric Railway and Light Company. This plant contains eight boilers, each with 13,060 sq. ft. of heating surface and burning about seven tons of coal per hour when operated at 300 per cent rating. In one 24.5-hr. test recently made at 136 per cent rating, the remarkably high thermal efficiencies of 85.6 and 90.2 per cent were respectively obtained for the boiler alone and for the boiler and economizer combined. In this test the CO_2 at the boiler uptake averaged 16 per cent, and in the gases leaving the economizer, 13.2 per cent. The gas temperatures were 432 deg. leaving the boiler, 392 deg entering the economizer, and 205 deg. leaving the economizer.

Frederick K. Scheffler[1] submitted a written discussion of the paper by Messrs. Kreisinger and Blizard, in which he said that the authors' tests confirmed other previously carried out and made it safe to state that a boiler and furnace efficiency of 80 per cent can be obtained with any kind of coal properly pulverized when burned in a plant designed to suit the operating loads and conditions.

H. G. Barnhurst[2] wrote that he believed the customary limitation of 85 per cent through a 200-mesh screen should be generally followed, but just how any particular coal should be prepared depended to a great extent on the amount of volatile and ash it contained. Granulation would not give really efficient results. Inherent moisture should not be confused with surface moisture, and the latter should be reduced to approximately 3 per cent. Coal should be dried before preparation—primarily to make transporting, storing and feeding easier.

Guildford Greig[3] wrote describing results obtained with a 400-hp. water-tube boiler at the Erie City Iron Works. The equipment was extremely simple, consisting of but a magnetic separator for removing tramp iron from coal before pulverizing, and a combined coal pulverizer and fan. The furnace had a water-cooled refractory lining, making it possible to burn coal with only 5 to 10 per cent of excess air. Neither drying equipment nor extreme fineness of grinding had been found necessary.

G. E. Pfisterer[4] in a written communication said that the tests were in the proper direction, for if the cost of drying and pulverizing could be reduced the field of usefulness of pulverized coal could be greatly extended. Since the heat absorption of the furnace coil mentioned in the paper was very large per square foot, it might be advisable to put it in circulation with the boiler.

Victor J. Azbe[5] said that Mr. Kreisinger had established a record of great economic importance in getting 90 per cent boiler efficiency. Now that this had been shown to be possible, an end should be made of the practice of operating boilers at between 50 and 60 per cent efficiency.

C. C. Trump[6] said that he had obtained an efficiency of 90 per cent with large boilers, underfeed stokers and economizers, and with at least 12 per cent CO_2 and with care in operation these figures might be exceeded. One advantage in burning fuel in suspension was the radiant quality of the flame, and part of the efficiency attained by burning fuel in pulverized form might be accounted for by the efficiency of heat absorption by direct radiation.

R. Sanford Riley[7] said that the results stated by Mr. Kreisinger set a new standard for possibilities in combustion. One limitation to the use of powdered fuel that might be mentioned was the high cost of the equipment as compared with that for stokers.

E. W. Wagenseil[8] called attention to the practically flat efficiency curve obtained in the Lakeside plant tests with pulverized coal for ratings from normal up to around 300 per cent, and said it was worth while noting that this was also possible with modern forced-draft types of stokers with a proper zone system of air control.

John A. Stevens[9] said that abroad the practice now was to preheat the combustion air, resulting in a gain of something like 2 per cent in the overall efficiency. A boiler efficiency of 90 per cent meant a kilowatt-hour on a pound of 14,000 B.t.u coal, and this high value could be increased still more by preheating with steam drawn from the second or third stage of the turbine.

Mr. Kreisinger, in reply to queries, stated that in the effiicencies he had given no deductions were made for the economizers; and

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[2] Chief Engr., Fuller Engrg. Co., Allentown, Pa. Mem. Am.Soc.M.E.

[3] Gen. Supt., Erie City Iron Works, Erie, Pa. Mem. Am.Soc.M.E.

[4] Green Fuel Economizer Co., 1450 Old Colony Bldg., Chicago, Ill. Jun. Mem. Am.Soc.M.E.

[5] Cons. Engr., 2194 Ry. Exchange Bldg., St. Louis, Mo. Assoc-Mem. Am.Soc.M.E.

[6] Vice Pres., Humphrey Gas Pump Co., 401 S. A. & K. Bldg., Syracuse N. Y. Assoc-Mem. Am.Soc.M.E.

[7] Pres., Stanford Riley Stoker Co., 25 Foster St., Worcester, Mass. Mem. Am.Soc.M.E.

[8] Commercial Stoker Engr., Westinghouse Elec. & Mfg. Co., 111 W. Washington St., Chicago, Ill. Mem. Am.Soc.M.E.

[9] Cons. Engr., Lowell, Mass. Past Vice-Pres. Am.Soc.M.E.

that powdered coal was safe to handle if kept out of the boiler-room atmosphere. Replying to Mr. Stevens, he said that by preheating the atmospheric air fed to the furnace 280 deg. the boiler efficiency could be increased approximately 3 per cent.

Management Session

THE session of the Management Division, presided over by L. P. Alford, Chairman of the Division, was opened by the presentation of a report of the work of the Executive Committee during she first year of the organization of the Management Division. This report defined management as the art and science of preparing, organizing and directing human effort applied to control the forces and to utilize the materials of nature for the benefit of man. From this definition the following statement of the purpose or object of the Management Division was enunciated:

Inasmuch as the problems of management are of the utmost complexity and difficulty, the Management Division of The American Society of Mechanical Engineers, in seeking to render disinterested service, therefore declares its purpose to be the formulation and declaration of the fundamentals of management, both regulative principles and accepted practice, and the dissemination of management knowledge. In working toward this object the Management Division can thus not only be of service to the other Professional Divisions of the Society, to the individual members of the Society and to all other societies of like aim, but also to all who are in responsible charge of human effort, and therefore through them of benefit to society at large.

The following activities of the Division in project were named: The standardization of management terminology, units of measurement, and methods of expression; the improvement and development of management education; the elimination of management wastes in industry; the elimination of unnecessary fatigue in industry and engineering; and lastly, management research. The report also listed the work of the Division in assisting local sections to conduct meetings during the past year. Two coöperative activities have been entered into, as follows: The joint committee on graphics with the Society of Industrial Engineers, the Taylor Society, and the American Statistical Association; and the joint committee on Management Terminology with the Industrial Relations Association of America, the National Association of Cost Accountants, the Society of Industrial Engineers, the American Institute of Accountants, and the Taylor Society.

Robert Thurston Kent presented a progress report of the Joint Committee of Management Terminology, of which F. E. Town is chairman. The report stated that the duties of the committee are the definition of management, the listing and defining of terms and phrases of management and the extension of the Dewey decimal system of classification to cover management literature. The Committee limited its field to management terminology applied (1) to production of basic materials for manufacture; (2) to manufacture, including products of public utilities; and (3) to construction of all kinds. In carrying out its work the Committee will request the submission of definitions of a tentative list of management terms from a great number of properly qualified persons and 98 colleges and universities. The definitions received will form the basis for the Committee's action in determining standards. Steps have been taken to form an advisory council composed of one representative from each of the large national trade or commercial organizations. In closing, Mr. Kent asked the membership of the several societies to assist by sending the chairman of the committee lists of management terms used in their shops.

A paper by W. C. Marshall, entitled Graphical Methods, was presented before the meeting. This paper will appear in a later issue of Mechanical Engineering. In a discussion of this paper, Morris L. Cooke pointed out that while the engineer is accustomed to the use of charts, drawings, tables, and blueprints, the general public is getting tired of these evidences of the engineer's technique. He stated it to be the duty of the engineers to make charts palatable and thereby greatly increase their effectiveness. L. W. Wallace further emphasized Mr. Cooke's remarks and stated his belief that education in graphics to catch and hold the eye and convey a lesson is a most important step in increasing public understanding of industrial matters.

In his paper on Industrial Waste, L. W. Wallace, Secretary of the American Engineering Council, presented some interesting facts resulting from the work of the Committee on Elimination of Waste in Industry. He pointed out that waste results from lack of planning, inadequate standards, faulty and uneconomic design, changes in style, and unfair practice; and predicted that the disclosures to be made in the report itself, which will be issued about September 1, will be interesting and vitally important. He gave a brief résumé of the work of the Committee from its appointment to the presentation of the report to the American Engineering Council on June 3, listing the problems solved, giving credit to the Committee members for their conscientious work, and outlining the final character of the waste report. He described the astonishment of the Committee upon finding after careful investigation that there was no known means or procedure for analyzing and evaluating waste, and pointed out the great value to management engineering of the method finally determined upon by the Waste Committee, the use and further development of which he commended to the Management Division. The difficulties experienced by the Committee because of the babel of management terms were explained by the speaker, who encouraged the Joint Committee on Management Terminology in their efforts.

In his discussion of Mr. Wallace's address, Morris L. Cooke pointed out the importance of the work done by the Committee in determining upon a method for waste evaluation and stated that the Management Division should utilize this method still further in the study of industry. Mr. Wallace emphasized the need of coöperation with other societies in putting this procedure to work.

Following Mr. Wallace's paper the meeting was turned over to a discussion of Mr. Cooke's paper on the Organization of an Engineering Society, presented at the Business Meeting of the Society on Monday, May 23. This paper, which was printed in the May issue, was prepared at the request of the Management Division and the discussion was held during the Management Session. This discussion will be abstracted in the August issue of Mechanical Engineering, which will also carry the proposed new constitution and by-laws of the Society, and should be given consideration by the membership of the Society in connection therewith.

First General Session

THE papers read at the General Session, Tuesday morning, Past-President D. S. Jacobus presiding, were Capacity Tests of Dry-Vacuum Pumps by the Low-Pressure Nozzle, by Snowden B. Redfield; and Report upon Efficiency Tests of a 30 000-Kw. Steam Turbine, by Herbert B. Reynolds. An abstract of Mr. Redfield's paper was printed in Mechanical Engineering for April; Mr. Reynolds' paper appears elsewhere in this issue. A brief résumé of the discussion follows:

Allen H. Blaisdell,[1] discussing the first paper, wrote that it seemed misleading to run tests on vacuum pumps using dry air rather than a mixture of air and vapor and then consider the results as indicating the actual capacity of the pumps.

Paul Diserens[2] said that the paper pointed out the ease with which a volumetric test of a vacuum pump or compressor might be made and emphasized the high degree of accuracy obtainable by the use of an orifice. He also called attention to the fact that the vacuum which a pump will develop on a closed suction gives a good indication of its volumetric efficiency throughout its entire working range. He then showed how closely calculated results and actual test results agree.

Wm. G. Christy[3] spoke of the length of the orifice beyond the curved mouth which the author had stated as ranging from 1/4 in. to 3/4 in. in length. He was under the impression that this should be as short as possible.

H. Boyd Brydon[4] said that a dry-vacuum pump should be tested under the conditions under which it was to operate, i.e., with moist rather than with dry air.

N. E. Taylor,[5] who presented the paper in the absence of Mr. Redfield, said that undoubtedly the moisture in the air influenced

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[2] Asst. Ch. Engr., Worthington Pump & Machy. Corpn., 115 Broadway, New York, N. Y. Mem. Am.Soc.M.E.

[3] Stillwater, Okla. Mem. Am.Soc.M.E.

[4] Byllesby Engrg. & Management Corp., Chicago, Ill.

[5] Engr., Ingersoll-Rand Co., Chicago, Ill. Jun. Am.Soc.M.E.

the results of the tests. The logical way to make the test, he said, would be to test the pump with dry air and then determine the effect of moisture.

The second paper was presented by H. Boyd Brydon in the absence of the author. The discussion was opened by the reading of the following communications here briefly abstracted.

O. H. Bathgate[6] noted that the water rates reported in the paper corresponded very closely to those obtained on another group of 30,000-kw. turbines reported by Messrs. Stott and Finlay, if proper allowance were made for difference in steam pressure and temperature. From this he concluded that it was hardly reasonable to expect any further increases in turbine efficiency for this size of unit unless obtained from units of radically different design.

W. S. Finlay, Jr.,[7] discussed certain ruling considerations such as the high price of New York real estate and the necessity and desirability of locating the turbines so as to secure their steam supply with proper distribution from the existing boiler plant. He stated the history back of the use of the spring supports for the condenser and many other details. He criticized the report for not being presented in metric as well as in English units.

Oscar F. Junggren[8] discussed the water-rate curve between 22,000 and 26,000 kw., saying that the secondary valve opened sooner than had been intended, resulting in a higher rate at this point.

Mr. Brydon asked a number of questions covering details of the installation and tests, which were answered by Mr. Junggren.

Frank R. Wheeler[9] said that he had used spring supports for condensers and had found them satisfactory. He had also used rubber expansion joints with copper thimbles to protect the rubber, with similar results. He called attention to the fact that about only half of the condenser surface was effective.

George A. Orrok[10] explained that condensers were designed for maximum conditions of steam and water temperatures, with the result that much of the time they were running at about half capacity. He also suggested hanging the condenser from the supports of the turbine so that a connection might be had between them without expansion joints.

T. E. Keating[11] mentioned the danger of overspeeding due to the admission of auxiliary exhaust steam unless the flow is under governor control. He asked for an explanation of the manner of determining the speed-curve corrections and the method of determining the heat transferred per hour in the condenser. He offered a tabulation of the heat-transfer coefficients as calculated from three of the tests and gave his assumptions in making the calculations.

Session on Education and Training

FOR the first time in the history of the Society a session was devoted to the subject of training for the industries at the Spring Meeting in Chicago. Dr. Ira N. Hollis, President of Worcester Polytechnic Institute and Past-President of the Society, called the meeting to order and introduced Dean Robert L. Sackett of Pennsylvania State College as presiding officer. In his opening remarks Dr. Hollis called attention to the importance of the problem of training for the industries as the phase of the present industrial crisis to which we have given least attention. The Society as a whole has no share in the establishment of schools and no responsibility for the training of men for the industries. Therefore the interest of the Society applies mainly to the dissemination of information to members and the public as to what is being done in remedying unsatisfactory conditions. Papers were presented by H. C. Smith, chairman of the Committee on Education of the National Metal Trades Association, on What the National Metal Trades Association is Doing and Intends To Do in Industrial Education; by Dugald D. Jackson, professor of electrical engineering, Massachusetts Institute of Technology, and Magnus W. Alexander, National Industrial Conference Board, New York, on The Requirements of Engineering Industries and the Education of Engineers; and by H. E. Miles on General Education and the Engineering Profession. The paper by Professor Jackson and Mr. Alexander appeared in the June issue of MECHANICAL ENGINEERING. Those by Messrs. Smith and Miles will appear in the August issue.

Chicago Session

THE Chicago Spring Meeting was noteworthy because of the policy of close coöperation carried out with the Western Society of Engineers. The session devoted to the consideration of the engineering problems of Chicago was given over to the city's transportation and terminal problems and the Chicago Terminal Committee of the Western Society presented its report at this session. F. K. Copeland, president of the Western Society of Engineers, was introduced as presiding officer by President Carman and the meeting was conducted throughout by that society. A considerable amount of valuable information was presented about the terminal problem in Chicago. The papers with their discussion will appear in the August issue of MECHANICAL ENGINEERING.

Second General Session

THREE papers were presented at the General Session, Wednesday morning, Manager C. Russ Richards presiding, namely: An Investigation of Oxy-Acetylene Welding and Cutting Blowpipes, by R. S. Johnston; Interpretation of Boiler-Water Analysis, by J. R. McDermet; and The Hydraucone Regainer, Its Development and Applications in Hydroelectric Power Plants, by W. M. White. Abstracts of the papers by Messrs. Johnson and McDermet appeared in MECHANICAL ENGINEERING for May; Mr. White's paper was published in abridged form in the June issue. A very brief account of the discussion of these papers follows:

H. G. Knox[1] discusses some tests made on blowpipes at the Norfolk Navy Yard about a year ago. In these tests more attention was paid to the mechanical features and serviceability of the various blowpipes, and the interest was not so much in the theoretical gas consumption as in the general economies of field service. The blowpipes were examined from three viewpoints: design, performance and upkeep. Subdivisions under these headings were rated on a decimal basis, the weighted average representing the final merit of the blowpipe.

James W. Owens,[2] writing also on the above-mentioned tests, stated that the oxy-acetylene cutting tools were tested on metal up to 8 in. in thickness, this being considered the practical limit. Above 8 in. oxy-hydrogen should be used. In addition to the tests outlined by H. G. Knox, a six-month's service test was also made.

Alfred S. Kinsey[3] asked if the channel mentioned by the author and used under the welding specimens was for the purpose of preheating in order to increase the strength of the weld The author replied that the channel was primarily used for convenience in bracing, but that it was noticeable in Table 6 that the second plate, which was subjected to greater preheating, was, in most cases, of higher tensile strength, which might indicate that preheating was valuable under certain conditions.

J. I. Banash[4] thought that the paper presented oxy-acetylene welding in too unfavorable a light. He brought out the importance of considering the personal element, and said that some of the criticisms were unjustified.

S. V. James[5] said that the safety of torches depended upon features of mechanical construction of far more importance than flashback, and thought that the author had overstressed this danger, which had never been of serious consequence in the industry.

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[7] Vice Pres., Am. Water Works & Elec. Co., 50 Broad St., New York, N. Y. Mem. Am.Soc.M.E.

[8] Engr., Turbine Dept., Genl. Elec. Co., Schenectady, N. Y. Mem. Am. Soc.M.E.

[9] District Mgr., C. H. Wheeler Mfg. Co., 1523 Marquette Bldg., Chicago, Ill. Mem. Am.Soc.M.E.

[10] Cons. Engr., 124 East 15 St., New York, N. Y., Mem. Am.Soc.M.E.

[11] Genl. Engr., Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa. Assoc-Mem. Am.Soc.M.E.

[1] Production Mgr., Winchester Repeating Arms Co., New Haven, Conn.

[2] Welding Aid, Asst. Shop Supt., U. S. Navy Yard, Norfolk, Va.

[3] Supvg. Instr., Shop Practice, Stevens Inst. of Technology, Hoboken, N. J. Mem. Am.Soc.M.E.

[4] Cons. Engr., 3642 Jasper Pl., Chicago, Ill. Mem. Am.Soc.M.E.

[5] M. E., Underwriter's Laboratories, 207 E. Ohio St., Chicago, Ill. Mem. Am.Soc.M.E.

Stuart Plumley[5a] thought the paper a serious indictment of the welding and cutting industry, and that the conclusions must have been based on a limited experience. The limit of depth of cut as set by the author was too low, while the tensile strengths reported were lower than those daily obtained in industry.

E. Wanamaker[5b] spoke of three primary features, economy of gas, quality of weld, and serviceability of the welding tool.

S. W. Miller[6] presented a written discussion of the paper in which he said that he considered the investigation of great value because it would do much to clear up erroneous and even foolish statements which had been made in the past. He pointed out that a tensile test on a non-uniform or non-homogeneous specimen must be interpreted with caution. It was too frequently assumed that the weld in a steel plate was of the same character as the plate itself. The weld, he pointed out, was a casting, of necessity more or less overoxidized, and metal in this condition had very different physical qualities from the original plate. These differences in quality he then discussed, and considered also the strengths of welds in general.

Mr. Johnston, in his closure, repeated the fact that the welders used in the tests were above the average and that none of the manufacturers of the blowpipes tested had complained of their skill. He hoped that the paper would not be considered as an indictment of the industry as it had been made as a scientific investigation to point out improvements which might be made.

D. S. Jacobus,[7] discussing the paper on The Interpretation of Boiler Water Analyses, spoke of the oxygen content of the water as affecting corrosion. Air can be removed from feedwater, he said, to the necessary extent by heating it in an open heater under atmospheric pressure at about 210 deg. fahr. Considerable economizer effect is thus lost due to the reduction of the temperature difference in the economizer, $1^1/_2$ per cent additional overall efficiency being secured, on an average, by allowing feedwater to enter the economizer at the lowest practical temperature rather than at 210 deg. fahr. aside from that which results through eliminating losses at the heater.

The author has not brought out the fact that he had been working on the development of the Elliott apparatus for the removal of air at ordinary feedwater temperatures so as to obtain the additional gain of $1^1/_2$ per cent in efficiency. Dr. Jacobus described the essential features of the apparatus.

Another reason for removing air from the feedwater was in order to increase the vacuum in the main condenser. This action may be obscured through leakage at the condenser.

G. E. Pfisterer[8] said that while the corrosion of cast-iron economizers due to oxygen was almost negligible, it was serious in economizers of steel. It was his impression that considerable experience might be gained from various installations of steel and cast-iron economizers now in use as regards the corrosive effects of oxygen and carbon dioxide. Comparisons would be difficult until figures regarding maintenance of steel economizers were available.

Discussion of Mr. White's Paper on the Hydraucone Regainer

The discussion of the paper on The Hydraucone Regainer was very voluminous and consumed so much time that an adjourned meeting was necessary in order to dispose of it. On account of limited space, it is possible to give only the briefest abstract of the discussion.

Geo. R. Shepard[9] surveyed the history of the tests which were made of draft tubes proposed by competing companies when the then Hydraulic Power Company was required by the Government in 1917 to proceed with the rapid development of additional power at Niagara Falls. The Hydraulic Power Company constructed a temporary laboratory with testing equipment substantially the same as shown in Fig. 19 of the author's paper and there were tested model draft tubes submitted by the competing companies. Some of the forms in addition to the hydraucone were (*a*) a straight draft tube as long as possible in the space available; (*b*) another form similar to this but flared partly at the end and fitted with a cone in the center; and (*c*) a curved draft tube very much flattened along the horizontal portion in an attempt to conform to the natural shape of the flow lines of the water. Finally an alternate design, Model "M," designed by Lewis F. Moody and of the symmetrically flared radial-discharge type was also adopted, and the hydraucone regainer used in the Allis-Chalmers units and the Model "M" in the others. The models were of 4 in. diameter of intake.

Tests of the models showed that Model "M" with the cone in the center, while not giving as high an efficiency as the model without the cone, seemed to have more uniform efficiency at greater or less velocities.

In addition to its efficiency, there is a practical advantage in the radial-discharge type of tube due to saving in excavation which is below tailrace water elevation and in most cases difficult and expensive.

Lewis F. Moody[10] denied the implication of the author that the draft tubes of Station No. 3 of the Niagara Falls Power Co., units 17 and 18, employ the hydraucone principle. These tubes, he said, were of the spreading-draft-tube type developed by him and were conceived along diametrically opposite lines to the tubes of the author. In this form of tube the water is received between two concentric surfaces of revolution in a direction tangent to both surfaces, and is guided along and not against the confining walls, being turned along curves having as large radii of curvature as can be conveniently adopted within the space restrictions of a plant, and deceleration of the flow is gradual and continuous at every part of the passage. The deceleration of the whirl components of velocity is made gradual and continuous by guiding all parts of the flow away from the axis along the central surface, and the deceleration of the meridian components is definitely controlled by the progressive enlargement of the annular cross-sectional area between the two surfaces according to a simple rule.

H. Birchard Taylor[11] wrote that the author confirmed his conclusions that in turbines of high specific speed, poor conditions of flow will exist in any form of draft tube which is not symmetrical with the axis of the turbine. In addition to this, he further stated that for best results in draft tubes the area through which the water flows from the runner to the tailrace should be enclosed between surfaces of revolution about the axis, and that both the axial and whirl components of velocity should be gradually and continuously decelerated. The author's tube did not meet this last requirement. The Moody tube, he pointed out, satisfied all three of the requirements.

Referring to Table 2 of the author's paper, the writer said that as an important consideration affecting the efficiency had been omitted, the assumptions given in columns 8 and 10 were extremely questionable and the results in column 12 incorrect.

In conclusion the writer stated that a free jet impinging on a flat plate or any other kind of plate involving in the jet pure streamline flow is a difficult condition to secure. It is a product of a laboratory and cannot be secured even there, except under ideal conditions, from a smooth orifice or nozzle attached to a reservoir. Although the author had demonstrated that by the use of a draft tube satisfying the conditions of symmetry it was possible to secure better results than in any form of draft tube which seriously violated these conditions, it must be clearly borne in mind that it is possible to design various types of draft tubes which satisfy these conditions without properly regaining all components of entering velocity. It was in the means for decelerating the velocity that the author and Mr. Moody were fundamentally apart.

F. Nagler[12] wrote that to his mind the remarkable feature of the hydraucone was found in the fact that the water can be turned abruptly at right angles in the conoidal chamber without appre-

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[11] Vice-Pres., Wm. Cramp & Sons Ship & Eng. Bldg. Co., Philadelphia, Pa. Mem. Am.Soc.M.E.

[12] Hydraulic Engr., Allis-Chalmers Mfg.Co., Milwaukee, Wis. Mem. Am.Soc.M.E.

ciable loss of efficiency. He was impressed by numerous instances of fairly close approach to the hydraucone principle but where the ultimate idea was not applied. Many tubes discharging against a flat plate have undoubtedly been investigated and numerous studies have been made in this country and abroad on the effect of a flat plate adjacent to the bottom of a vertical draft tube. These came under two heads:

a The work in question was done to overcome what was thought to be a positive disadvantage resulting from the proximity of the bottom of a tailrace;

b The work was performed to permit of some mechanical arrangement of cylindrical gate at the discharge of a wheel or in the attempt to apply a radial Boyden diffuser to some form of an axial-flow wheel.

The writer did not completely agree with the concluding paragraph of the paper. It could not be denied, of course, that any disturbance in the water at the exit end of a draft tube represents energy loss, but the extent of the loss was often overestimated.

L. F. Harza[12a] submitted a mathematical analysis of certain features of the author's paper and asked for additional data.

Arthur M. Greene, Jr.,[13] wrote that from Fig. 18 of the paper it seemed to him that the velocities recorded indicated a condition of disturbance, in that the various streams were moving at different velocities and were therefore moving one over the other and possibly permitting cross-flow.

Chester W. Larner[14] called attention to the fact that the author claimed to base his draft-tube design on the shape of a free jet impinging on a plate and that it was necessary to take into consideration the action of this free jet as it struck the plate if maximum recovery of velocity head was to be expected. This treatment was open to criticism for the following reasons:

1 A free jet presupposes straight-line flow, which does not occur in a draft tube;

2 The object of a draft tube is recovery of velocity head and there is no recovery of velocity head in a free jet, and

3 The author does not adhere to the free-jet principle in working out his own designs.

George F. Lovett,[15] who had been in direct charge of ten installations of the hydraucone regainer, wrote that it had been used in order to avoid the excavation of great amounts of ledge. The efficiency of the units had never been determined but their output had exceeded expectations.

Edward W. Burbank[16] wrote that as the design of the hydraucone can be changed as to its radius and as to volume of its conoidal chamber, the latter principally by placing cones of various sizes at the center of the bottom plate, it was not difficult to see that certain recently constructed regainers are in reality a variation of the hydraucone.

Arnold Pfau[17] wrote that the hydraucone regainer accomplished all that it should, namely—

1 Transforming the static suction head into pressure;

2 Transforming the kinetic energy of the discharging water into pressure, and

3 Transforming into actual head such energies as are latent in the disturbances.

Mr. Pfau added orally that he had found when in Europe recently that the turbine manufacturers there had not paid sufficient attention to the draft tube. American engineers, however, had fully realized its importance and had gone into its development far beyond those of other countries.

Joseph J. Ring,[18] writing of the research done on draft tubes and the development of the hydraucone regainer, said that the natural conclusion was that by using the hydraucone regainer with a runner of almost any specific-speed results could be obtained in the commercial power house as good as the best obtained at the Holyoke Testing Flume with the best possible testing equipment, without excessive excavation or prohibitive cost in the power house or in the hydraulic equipment used.

J. R. James[19] pointed out that the reduction of the depth of excavation was an important feature of the hydraucone regainer. He also suggested that the principle might be applied in steam plants in handling the water used in condensing. Water starting from the intake canal, passing up through the pump and through the condenser tubes and then dropping into the tailrace was in reality an inverted siphon. Therefore any method which would change velocity head into pressure head when the water enters the tailrace would help out the circulating pump to just that extent.

In the oral discussion Gardner S. Williams[20] referred to investigations he had made at Detroit and at the Cornell University laboratory regarding the flow of water and losses to pipe curvature. In 1899–1901 he had supervised tests of the hydraulic machinery of the Lake Shore Power Co. then being installed at Sault Ste. Marie and had conducted what was probably the most extensive investigation into the performance of water wheels attempted up to that time. After extended tests on a pair of wheels mounted on a single shaft and discharging horizontally in opposite directions, which was accepted practice in all low-head installations at that time, he decided to test the individual wheels with a vertical setting—something that had not hitherto been done—and the results showed a gain of 2 per cent in efficiency. He therefore felt a pardonable pride in having been the originator of the vertical setting for low-head installations. The curved draft tubes he had employed there were not very different from what had been recognized as standard elbow draft tubes for a number of years back. Along in 1912–1914 he had had an opportunity of designing a two-unit plant—the Argo Plant mentioned by the author—for a head of about 14 ft., and the draft tubes were designed by him following out his earlier investigations of the variation of velocity as water passes around a curve in a closed pipe. He had reason to suppose that the results obtained in testing that plant had made it possible for the author to carry out the experiments that had been described in the paper.

Later, in another plant, he had designed a draft tube in which four steel blades or fins projected about 8 in. beyond the wall of the draft tube, which checked the whirl of the water to a considerable degree. He felt entirely warranted in saying that for moderate heads it was possible to design an elbow draft tube that would give as high an efficiency as had yet been obtained by any other device. He did not wish to be understood, however, as saying that that was the best thing to do, the most economical or the most desirable, because it depended altogether on the conditions of the installation. The hydraucone called for a greater width than was required in the curved type of draft tube, and it was a matter of width of foundation versus depth. Conditions might be such that width would be cheaper. Generally, however, he thought that width would be less expensive, and therefore practical men would probably use the hydraucone or some similar device in the majority of cases.

C. B. Spellman[21] told of work he had done in redesigning a large, noisy centrifugal pump in which he had employed the Lorenz theory, one principal point of which was that in a right-angled bend the inner radius must be larger than the outer, which latter might even be a sharp angle. From the results of his observations in this work he believed that, referring to Fig. 18, the cone could be omitted and a sharp turn employed at the center where the velocity was very low and the pressure high.

The author in closing said that Mr. Taylor's point regarding one of the tables in the paper might be well taken; what he said regarding the whirl was true. Mr. Shepard's presentation was an unbiased statement of the facts. Mr. Moody had undoubtedly thought out and worked out his tube independently, but he had tested an identical one four years before. Fig. 18 of the paper had been developed to disprove a statement in Church's "Me-

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[17] Cons. Engr., Hydraulic Dept., Allis-Chalmers Mfg. Co., Milwaukee, Wis. Mem. Am.Soc.M.E.

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[19] Engr., The Detroit Edison Co., Detroit, Mich.

[20] Consulting Engr., Cornwell Bldg., Ann Arbor, Mich. Mem. Am. Soc.M.E.

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chanics" to the effect that the formula $v^2 = 2gh$ is applicable to the pitot tube. He then showed several slides and concluded by saying that it should be borne in mind that the discussion was not on the relative merits of the hydraucone as compared with other devices. Competitors must and should have something of the kind, and the fact that 93 per cent efficiency had been obtained on the water wheel with the hydraucone and with another device showed that they were substantially the same thing. He would reserve extended comment until he had had sufficient opportunity to consider carefully the various discussions that had been submitted.

Power Test Codes Session

THIS session, held on Wednesday morning, Past Vice-President F. R. Low presiding, was a public hearing called for the purpose of discussing the proposed A.S.M.E. power test codes on General Instructions, Reciprocating Steam Engines, and Evaporating Apparatus. The first two codes were adopted with such slight verbal changes as the Committee might find were necessary to make them consistent with themselves and with other codes. The third code was referred back to the individual committee having it in charge for consideration at a conference to be held later with a similar committee of the American Institute of Chemical Engineers.

Railroad Session

THREE papers were presented and discussed at the Railroad Session on Thursday morning, namely: Advantages of Large Freight Locomotives, Particularly the 2-10-2 Type, by Albert F. Stuebing; The Design of Large Locomotives, by M. H. Haig; and The Necessity for Improvement in Design and Operation of Present-Day Locomotives, by H. W. Snyder. Mr. Haig's paper was printed in the May Mechanical Engineering; the papers by Messrs. Stuebing and Snyder appear in this issue. In the absence of W. H. Winterrowd,[1] who had been selected as Chairman, Wm. L. Bean[2] presided.

In discussing Mr. Stuebing's paper, A. W. Bruce[3] wrote that it was practically impossible to compare engine maintenance costs on different roads because of the varying methods of accounting employed. It would be advisable, therefore, to adopt a uniform system which would also include electric installations.

O. C. Cromwell[4] said that in mountainous country the tunnel clearances made it necessary in designing heavy-powered locomotives to use limited bearing areas that contributed to increased cost of maintenance and kept down size of boilers. Probably more coal was burned because of lack of proper lubrication of cylinders than was wasted in any other direction. Further, machining of parts was not given the attention it should and formerly did receive.

P. R. Duffy[5] said that on eastern roads the Mallet and Mikado type engines did not appear to have as large tenders as they should have. Experience on his road for 16-hr. turn-about service had shown that the long, low tender carrying 15,000 gal. of water and 18 tons of coal was the most suitable.

Discussion of Mr. Haig's Paper on the Design of Large Locomotives

Mr. Haig's paper was also discussed by Mr. Bruce, who wrote that locomotives should be designed particularly for the work to be performed and then used for that class of work. Failures too often occurred from faulty pipe connections, fittings, etc. Proper maintenance of shoes and wedges, boxes and rods, etc., would go further toward keeping engines in service than anything else. Floating bearings if properly lubricated would give good service on main pins for main and side rods. Fireboxes should have crown and sides in one piece where possible. It might be well to consider cutting away the front part of the cab on large engines where no front door is obtainable to provide accessibility to the firebox staybolts.

Referring to the same paper, R. W. Brown[6] wrote that the New York Central had experienced more difficulty with cracks in spokes between the crankpin hub and the rim than between the hub and counterbalance. This difficulty was one for the steel foundries to remedy. There was a question whether the union link connected to the crosshead pin was as satisfactory as the long combination lever. Records of his road showed many breakages of piston rods just outside of the crosshead fit, as well as through the metal of the keyway. Rods should not have sharp corners or shoulders at the crosshead end. Cored pockets should be provided in braces where they bear against frames or other parts, so that when bolted together a full bearing area will be provided. To avoid cracking the shell, the New York Central uses a wearing plate around the boiler upon which the boiler brace angles can rest without rivets or other fastenings.

W. E. Symons[7] wrote that defects in steel castings for crossheads and other parts, shrinkage cracks, etc., could be detected by first immersing the part in benzine or kerosene, and then, after thoroughly wiping it, applying a coat of white paint or whitewash, following which the defects would be made apparent. Crosshead keys should not be driven home until given a preliminary test drive by a foreman and certified to over his signature. Forced feed for lubrication of cylinders and valves should be considered in view of the long life of packing rings in superheated-engine cylinders so equipped. It might be well to undertake an investigation to determine the relative values of grease and oil as locomotive lubricants.

C. J. Mellin[8] wrote that the Laird crosshead was suitable for slow-speed engines, but it had been almost entirely superseded by the alligator type. The introduction of the Walschaerts gear had made it possible to satisfactorily brace frames, but the design in Mr. Haig's paper seemed to him somewhat lacking in tram bracing for so large an engine.

J. G. Blunt,[9] in a written discussion, suggested that axles, boxes and bearings be standardized for the engine truck as they have been for the tender. Draw-pin bearings, center plates, side bearings and other working parts would respond surprisingly if supplied with lubricant, thus increasing hauling capacity and reducing maintenance. A frame to best resist combined stresses should follow as closely as possible the lines of a tube. It would be well to consider making the water column of steel tubing and placing all live steam pipes outside the cab.

J. E. Muhlfeld[10] wrote it was of the utmost importance to reduce weights of all reciprocating parts and that exceedingly large freight locomotives should be designed so that piston thrusts and stresses and the reciprocating weights will be distributed rather than centralized in order that excessive total rail pressures will not be produced by any pair of drivers. Locomotives should be able to double their present daily mileages. Certain means and methods that would increase locomotive starting power and hauling capacity and promote fuel economies without any considerable outlay were: Reduction of abnormal factors of adhesion by increasing working steam pressures from 5 to 20 lb.; increase in superheat; application of arched tubes in fireboxes; revision of locomotive ratings in order to utilize the increased capacity provided by the foregoing changes; distribution of locomotives over divisions and districts so as to insure maximum percentage of gross ton-miles hauled to locomotive rating ton-miles; purchase of most suitable materials for renewals and repairs; first-class enginehouse maintenance, packings, boilers, superheater, draft appliances, arches, etc.; establishment of adequate and effective central and field supervision.

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[9] M. E., Am. Locomotive Co., Schenectady, N.Y. Mem. Am.Soc.M.E.

[10] V. P., Railway and Industrial Engrs., Inc., 25 Broad St., New York, N. Y. Mem. Am.Soc.M.E.

F. E. Cardullo[11], who opened the oral discussion, said he felt that the developments in other lines of engineering had been such as to seriously raise the question of whether the design of locomotives ought not to be radically changed. The matter of condensation should be considered, for the arguments of 15 or 20 years ago no longer held. Radical designs should be put under way and tested to see if further advantages could not be had through rearrangement of some of the most important parts, counterbalancing, etc.

C. C. Trump[12] asked what the objections were to water-tube boilers and increasing the number of cylinders, and whether they were sufficient to offset the advantages they would give; and whether the advantages due to longer divisions and runs were sufficient to justify the use of superheaters, economizers, heaters, condensers and new methods of firing fuel.

H. Wade Hibbard[13] advocated the greatest possible rigidity in the frame, which he thought should be of box section throughout and all one steel casting. Castings of similar shape were now being successfully made.

O. C. Cromwell[4] said that if the steel castings used in locomotives were properly heat-treated their strength and durability would be increased and internal stresses largely eliminated, resulting in considerably lower maintenance charges. The location of cross-braces and brake rigging and the spring arrangement made it difficult to design a box-section frame. Broken frames could be largely reduced in number if the pedestal binders were kept tight and in place. The feet of the cross-braces should extend even further along the length of the frame than proposed by Mr. Haig in order to get more bolting in the frame to secure the casting.

E. B. Katte[14] said that he understood frames could be cast in steel integrally—the two sides cast with cross-transoms—and that in new locomotives constructed for the Paris-Orleans Railway of France these will be supplied.

Mr. Haig, in closing the discussion, said that the objection to additional cylinders was that they increased the cost of maintenance. The fire-tube type of boiler had been continued in locomotive service because it had been found to meet the conditions in a most practicable manner. With water-tube boilers wash plugs would be required at each end of each tube, the removing and replacing of which would add to the expense and would make it more difficult to clean the tubes. One-piece box-section frames had already been cast, but he did not know of any such frame actually having been applied to a locomotive. The leading objection to their use was the lack of facilities in the repair shops to care for them. The reinforcing features mentioned in the paper in connection with cylinders were intended to prevent their breaking when the heads were knocked out.

Discussion of Mr. Snyder's Paper on the Necessity for Improvement in Design and Operation of Present-Day Locomotives

A. W. Bruce[3] submitted a written discussion in which he said that the so-called floating bushing had been used on heavy-power engines on the main pin for both main and side rods, and when properly lubricated this loose bushing gave good satisfaction. The use of special steel for light parts, while desirable, was questionable until assurance could be had that the same steel would be carried in stock and used for replace parts.

H. B. Oatley[15] wrote that probably less attention had been paid to the more economic production of front-end draft than to any other detail connected with locomotive design; and that intensive work along this line was eminently desirable. There seemed to be no reason why 2 1/4-in. boiler tubes should be the upper limit in practical use. Long, small-diameter tubes unduly increased the resistance to flow of gases and would nullify to some extent the evaporative capacity unless the front-end draft was greatly increased. He had for several years advocated using 2-in. tubes when the length was from 15 to 17 ft. and up to 2 3/4-in. for 30 to 33-ft. lengths, the shorter lengths being for soft coal and the longer for anthracite, oil and pulverized fuel. Domes had been gradually growing smaller and smaller. The absence of a dome however did not mean that practically dry steam could not be delivered to the superheater proper, but that the throttle, superheater (if any), dry pipe, etc., must be so arranged as to take care of the conditions. With long boilers on grades the rolling and surging would often cause slugs of water to splash up into the dome and pass to the superheater where they would deposit scale and produce deterioration.

C. J. Mellin[8] wrote that in regard to the matter of counterbalancing, the best method available appeared to be to use three cylinders and a single internal crank on the driving axle, which was a simple construction and provided room for parts of ample strength and bearings of ample size. While not giving as good a balancing effect as four cylinders, the method had the greater advantage of affording a better turning effect than any other means that might be suggested.

J. E. Muhlfeld[10] wrote that practically all of the 65,000 locomotives in the United States today were primarily improved enlargements and rearrangements of Stephenson's pioneer "Rocket," built in 1829. To improve their performance and efficiencies one of the simplest and most expedient means was to increase the boiler pressure and thus reduce the factor of adhesion. Superheaters, brick arches, feed heaters, etc., would increase sustained horsepower and promote fuel economy, but they did not materially affect the true capacity value of the locomotive, which was its starting power. With existing driving-wheel load limitations there was no reason for the factor of adhesion in freight locomotives to exceed 4 or 4.1 as a maximum when the limiting friction for dry sanded rail would allow a factor of 3 and for dry rail 4. Due to improper gas-area ratios, too few elements, or location of the superheater element rear return bends too far from the firebox flue sheet, many locomotives were being run with 50 to 100 deg. less superheat then would otherwise be obtainable. The use of 350 lb. steam pressure and 300 deg. superheat together with a more efficient boiler, improved combustion, better steam distribution and utilization of waste heat, would put the steam locomotive in a class by itself as the most effective and economical self-contained mobile power plant for the movement of fast and heavy rail tonnage.

Max Toltz[16] said that the water-tube boiler had been used by the French since 1903, particularly in Algeria. They were now used on ships where in heavy seas the foundations similarly lacked rigidity. The simple engine was to be preferred to the compound, but steam pressures should be increased and superheaters employed.

W. E. Woodward[17] said that 20 years ago 70 hp. developed per five tons of locomotive weight was good practice. Now, however, 100 hp. for the same weight was common. The 3500-hp. engine at present used to pull fast, heavy trains weighed about 350,000 lb. If designed according to practice in 1900 to 1905 it would weigh at least 500,000 lb., could not be run on railroads, and would have a boiler so large that it could not be fired properly.

C. T. Ripley[18] thought that in future development work on the locomotive, the manufacturers, railroads, members of the mechanical societies and the universities with their faculties and equipment should be brought together, for their coöperative work would surely produce results quickly and at much lower costs.

In closing the discussion Mr. Snyder said that from his viewpoint the most economical railroad operation consisted in hauling the largest load possible. Capacity should be increased as it had been in marine practice, where no one would care to go back to the caravels of Columbus from the huge ocean liners of the present day.

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[12] V. P., Humphrey Gas Pump Co., 401 S. A. & K. Bldg., Syracuse, N. Y. Assoc.-Mem.Am.Soc.M.E.

[13] Prof. M. E., Univ. of Missouri, Columbia, Mo. Mem. Am.Soc.M.E.

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Materials Handling Session

THE importance of machinery and its intelligent use in the building of roads furnished the topic for the first meeting session to be arranged and conducted by the Materials Handling Division. The subject was treated in the following papers which appeared in the June issue of MECHANICAL ENGINEERING: Planning and Organizing a Road Job for Mechanical Handling of Material, by C. D. Curtis; Road-Construction Plants, by B. H. Piepmeier; and Mechanical Needs in Highway Construction Methods, by R. C. Marshall, Jr. A lively discussion elicited from members and road-building contractors resulted in a successful session which laid the foundation for future coöperative gatherings between contractors and engineers.

In the written discussion William Ord[1] presented an analysis of the savings in investment and reduced overhead expenses when using one high-capacity plant instead of several smaller plants of the same total capacity as the large plant. He pointed out that with six months for actual mixing and six months for preparation twenty miles of 18-ft. road per year is a reasonable task for one plant if general conditions, such as labor, transportation and material supply, can be satisfactorily maintained.

William P. Blair[2] combatted the idea that standardization of road-improvement equipment is practical to a great degree in road-building machinery. He stated three elements of importance leading to the use of mechanical equipment, namely: reduced cost; elimination of rehandling; and proper scheduling so that no step will hinder the performance of any other portion of the organization or machinery.

In the oral discussion, E. H. Lichtenberg[3] emphasized the importance of standardization of equipment and methods of road building. He also spoke of the need for mechanical engineers to study carefully machine parts so that breakage might be eliminated as far as possible. Dean R. L. Sackett[4] compared the large road-building plant with the smaller plant, pointing out the ease of keeping up the supply of parts when a number of small similar machines were used. He also emphasized the need for protecting from grit bearings subjected to severe wear. Attention to such details of design should result in road machinery with a longer average life than four years.

Zenas Carter[5] quoted road builders of standing to the effect that proper drainage is by far the most important requirement for successful road building. Second, however, is the question of personnel, upon which he dwelt at some length. He also emphasized the need for awarding contracts to contractors who could do the work properly rather than to men who submitted the lowest bids. He stated the procedure in London, where the contractor who lays the road must keep it in condition for 15 or 20 years. Mr. Carter also advocated experimental highways in the building of which new mechanical devices might be tried out. O. B. Zimmerman[6] gave the results of his experience in the use of manufacturers' ratings in purchasing road-building equipment for the Government, where lack of a sound basis led to confusion and dissatisfaction. He suggested that the Materials Handling Division take up the standardization of ratings and parts for road-building equipment.

The afternoon was spent in the showing of moving pictures, the titles of the films being as follows: Modern Concrete Road Construction, with explanatory remarks by E. H. Lichtenberg; Methods and Machinery Used in Constructing and Maintaining Earth, Gravel, Macadam and Rigid-Surface Roads, with explanatory remarks by William Ord.

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[1] Manager Road Department, Lakewood Engineering, Co. Cleveland, Ohio.

[2] Secy. National Paving Brick Manufacturing Association, Cleveland, Ohio.

[3] Chief Engineer, Koehring Machine Co., Milwaukee, Wis. Mem. Am. Soc.M.E.

[4] Dean of Engineering, Pennsylvania State College, State College, Pa. Mem. Am.Soc.M.E.

[5] Sales Director, Austin Machinery Corpn., Chicago, Ill. Mem. Am. Soc.M.E.

[6] Export Department, International Harvester Co., Chicago, Ill. Mem. Am.Soc.M.E.

Forest Products Session

THE Forest Products Session was arranged by the organizing committee of the newly formed Forest Products Division. Robert B. Wolf, a member of this Committee and Vice-President of the Society, presided.

One paper, on the Paper Industry of America Dependent upon a Permanent Wood Supply, was presented by Hugh P. Baker, executive secretary of the American Paper and Pulp Association and formerly dean of the Forestry School at Syracuse University.

In his paper Dean Baker outlined the history of paper manufacture and showed the increase in the use of wood pulp for paper until today only 2 per cent of paper is made from pure rag stock. He spoke of the old methods of pulp grinding and pointed out that the chemical methods of reducing wood to pulp have been the basis for the rapid growth of the industry and a considerable price reduction.

Dean Baker listed the kinds of woods most desirable in the manufacture of pulp. The conifers are especially profitable because of the fiber length and ease of reduction to pulp. Hard woods have large possibilities in the paper industry.

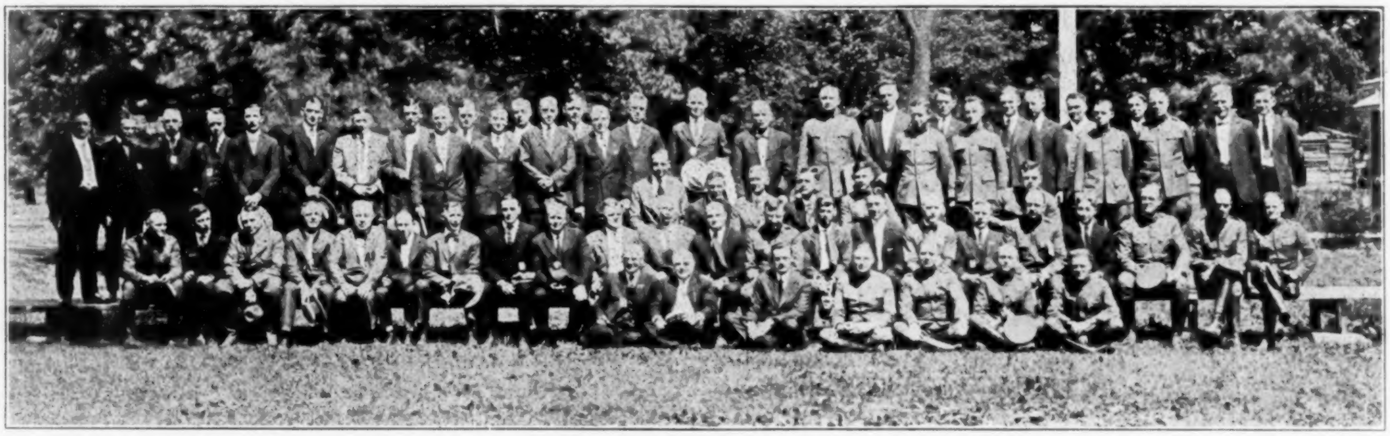
Having shown how important a permanent wood supply is in the paper industry, Dean Baker stated that at the present time less than two-fifths of the timber in the original forests of 820 million acres is left for our industries and for constructive purposes. The traditional feeling on the part of the early settlers that the forests were a hindrance and a menace to their safety has logically developed the present attitude of indifference or opposition to forest conservation. Various estimates during the past 20 years have been made of the supplies of timber left. There are still fine forests of considerable extent, and with proper protection from fire these forest areas reproduce rapidly. Increased use of forest products makes it absolutely essential that forests be protected from fire and that progress be made in forest renewal.

The paper industry is interested in the stand of timber east of the Mississippi, for that is where the paper mills are. Of the 2215 billion board feet still standing, less than 900 billion are in this region. Of the wood taken out of the forests it is estimated that two to three per cent of the total quantity is used by the paper industry. Twenty-two per cent of the pulp used in the United States paper mills during 1920 was imported from Canada and Europe. Spruce is the most popular wood for pulp, 58 per cent of the total used being of this species.

The discussion of Dean Baker's paper centered around the utilization in the pulp mill of sawdust, shavings, sawings, short lengths, etc. Consensus of opinion seemed to be that because of the dirt always present, such waste, unless cleaned, which is an impossible process in the case of sawdust, is used with difficulty. Moreover sawdust packs, gets soggy, and therefore does not adapt itself to the process of paper making. The presence of knots in wood introduces an added difficulty. Waste wood can be rendered available only by very careful sorting. Furthermore all present were agreed that the economic utilization of wood waste was not so important an item as that of getting waste out of the way. In lumber-using factories it was therefore generally better to burn the waste, even though in some cases it might be necessary to install special apparatus for the purpose. A number of those present told of practices in the more economical use of wood waste which had considerably reduced the fuel bills of their factories. It was stated that sawed blocks of mixed woods, after having been thoroughly cleaned, might be used in the soda process of pulp making. The chairman pointed out that the largest waste in a paper mill is waste in the utilization of the intelligence of the workman, due primarily to lack of proper provisions for showing him the best methods and to lack of records so that intelligent work may be properly rewarded.

A resolution was presented to the meeting in which it was recommended to the Council that the Society go on record as in favor of a systematic forest policy promulgating definite plans by means of which, with the coöperation of public and private agencies, a prompt solution may be found for this extremely important national problem.

At the closing of the meeting the following executive committee of the Division was elected:



Group of A.S.M.E. Members at Rock Island Arsenal

Grant B. Shipley, president, Pittsburgh Wood Preserving Company, Pittsburgh, Pa.

Thomas D. Perry, vice-president and secretary, Grand Rapids Veneer Works, Grand Rapids, Mich.

Sern Madsen, mechanical engineer, Curtis Companies, Inc., Clinton, Iowa

Charles E. Paul, consulting engineer, National Lumber Manufacturers Association, Chicago, Ill.

Carle M. Bigelow, chief industrial engineer, Cooley & Marvin, Boston, Mass.

O. H. L. Wernicke, vice-president, Pensacola Tar & Turpentine Company, Gull Point, Fla.

Power Session

At the Power Session, Thursday morning, Samuel Insull[1] presiding, two papers were presented: Location and Distribution of Central Station Power in the Middle West, by W. L. Abbott, and Future Power Development in the Middle West, by C. W. Place. Mr. Abbott's paper is printed elsewhere in this issue. Mr. Place's paper, which will appear later in Mechanical Engineering, dealt with certain phases of the question of power production and use. In it he outlined a system in which the fairly efficient steam power plants in the 100 odd cities of over 25,000 population in the 14 central states would be interconnected, not by heavy high-voltage lines, but by lines which would pick up the small town and village load to the point where its next larger neighbor would take its share; hydroelectric plants would be installed on the streams near the towns and villages, each with a small pondage; the steam stations would carry the steady continuous load above the maximum stream flow and the hydroelectric plants would automatically come on to carry the peaks. On the off-peak period the hydroelectric plants would restore the pondage and carry local load. The quickness with which the latter could get on the line (12 to 30 seconds) would enable the steam stations always to work at maximum efficiency. Mr. Place took occasion to urge engineers to use their power of straight thinking to assist the civic, political and financial interests in arriving at right conclusions.

In opening the discussion Chairman Insull pointed out that the great interest developed recently in the subject of the location and distribution of central-station power in the Middle West was undoubtedly due mainly to the taxation of transportation facilities during the war. It took that war to convince the country that concentration of production of energy was in the interests of the whole people. The superpower scheme as presented in the East was very good in itself, but he believed that if engineers would pay more attention to similar projects in their immediate localities they would accomplish more than by considering the matter as a general proposition. It was seldom that there were ample supplies of feed and condensing water where coal was produced economically. A proper location of power stations and economic tying up of existing facilities would relieve the railways of some of their burdens, hasten the day when their power would be furnished more economically than by steam locomotives, and afford an opportunity of supplying electrical energy to every hamlet and farm as cheaply as it was done in large cities.

W. E. Bryan[2] said that the United Railways of St. Louis used about half of the energy generated at the Keokuk hydroelectric plant. In order to insure continuity of supply, however, they felt it necessary to have installed in St. Louis considerably more steam-generating equipment than was needed to care for the loads day in and day out.

Geo. A. Orrok[3] said that the point had not yet been reached where an electric transmission line could be built that was proof against the direct stroke of lightning. It was therefore necessary to have practically a full steam reserve if dependence was to be placed on a long-distance line and where continuity of service was the desideratum.

As to the use of spare hydro power to pump water up to a storage reservoir to be used through a turbine and generator at the time of the peak load, this was practicable if a natural storage pond was available near by, but to build a reservoir of any considerable size would cost more than could be gotten out of it.

John A. Stevens[4] spoke of interconnection of stations in England, where under the rulings of the Electricity Commission it was allowable to draw on the less efficient stations only when their capacity was required. In Italy provision was made by the government for the protection of the investment in those stations in an interconnected system where the cost of producing energy was higher than in the others.

Chairman Inull in closing the discussion told of the development of interconnection in Illinois and neighboring states. Already there was practically a continuous system of distribution extending from Minneapolis southward to St. Louis and Louisville save for gaps totaling about 120 miles. The diversity of demand existing between city and country would go a long way toward providing a load factor that would amount practically to continuous use. No concern should be allowed to generate energy that would cost more than it could be bought for. He had advocated regulation for 25 years and believed that the various state utility commissions should be empowered to regulate the industry much more drastically than formerly along economic lines, for it was just as interstate in character as the railway and the telephone.

Aeronautic Meeting at McCook Field

The visit of the Society to the McCook Field Air Service Station on May 21 was something more than a sight-seeing pilgrimage to a point of engineering and patriotic interest. It was a plan instituted by the new Aeronautic Division of the Society to develop the interest of the membership, and the engineering profession in general, in the national aviation policy, both govern-

[1] Pres. Commonwealth Edison Co., 72 W. Adams St., Chicago.

[2] Supt. Power Stations, United Railways Co. of St. Louis. Assoc-Mem. Am.Soc.M.E.

[3] Consulting Engr., New York City. Mem. Am.Soc.M.E.

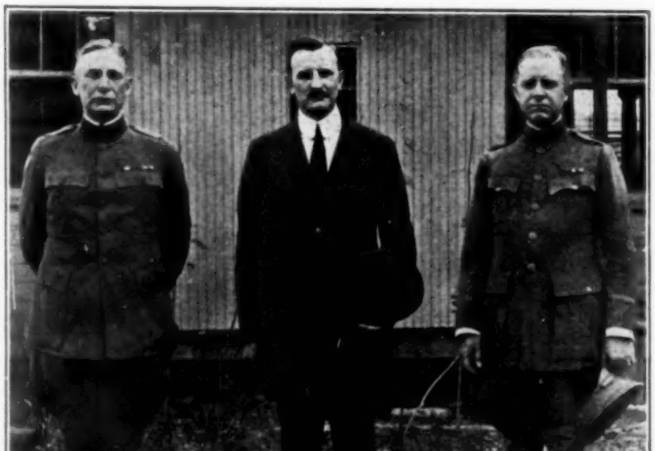
[4] Consulting Engr., Lowell, Mass. Past Vice-Pres. Am.Soc.M.E.

Airplane View of McCook Field

mental, through the Air Service, and commercial, which latter should be of especial concern to all of us.

The Air Service officers at Dayton, as well as their superiors in Washington, were successful in stimulating the engineers who participated in the trip to the realization that progress in the art from now on was to a large extent dependent upon their sympathy and support, and that if the United States wished to develop an efficient defense arm in the air, coöperation between governmental and industrial agencies should be developed as rapidly as possible.

The Society of Automotive Engineers, which has done so much valuable work in this field, participated in the visit. The S. A. E. members were on their way to their own spring convention at West Baden, Indiana, just as ours were to our Chicago convention. The



From left to right—Col. C. L'H. Ruggles, Chief of Technical Staff; E. S. Carman, President A.S.M.E.; and Lt-Col. Harry B. Jordan, Commanding Officer, Rock Island Arsenal.

registration at McCook Field was 203; twelve states were represented. There were of course large contingents from Dayton, Cincinnati, and Springfield, Ohio.

The Air Service had prepared an elaborate program, which was carried out to the letter, with the result that ample time was available for all events.

The arrangements at the Field were in charge of Major Thurman H. Bane, Commanding Officer; Major George E. A. Hallett, Mr. Glenn Martin, and Mr. Joseph A. Steinmetz, chairman of the A.S.M.E. Aeronautic Division. The officers at the Field all assisted; of these Lieut. E. E. Aldrin is secretary of the Executive Committee of the Society's Aeronautic Division.

Distinguished visitors were Messrs. F. Handley-Page and Griffith Brewer of England, and Orville Wright and C. F. Kettering.

Promptly at ten in the morning the visitors assembled and Major Bane outlined the program of the day. The forenoon was given over to inspections of the materials laboratory, the shops, and the power-plant laboratory—all splendid examples of engineering practice embodying many features of interest.

A unique feature was the armament-testing laboratory, at which exhibitions of synchronized firing attracted much attention.

Then came an inspection of airplanes on the line—thirty-one machines in all, ranging alphabetically from Caproni to Thomas-Morse, and from bombers and pursuit to honeymoon express in type. Sixteen of these machines were flown.

Following a splendidly served lunch at the Field's cafeteria, there was a professional session in the Auditorium, with papers by E. H. Dix, S. D. Heron, Bayard Johnson, C. F. Taylor, Gerald P. Young, O. E. Marvel, G. W. Stevens, and A. O. Russell, all of the Air Service Station. The respective subjects were Aluminum Cylinder Castings; Air-Cooled Airplane Motors; Airplane Radiators; Carburetor Problem on Aircraft Engines; Color Camouflage; Radio Apparatus, Including Direction Finders; Aerial Photography; and Machine-Gun Synchronizers. These papers will be abstracted in a later issue of Mechanical Engineering. Chairman Steinmetz presided at the professional session.

In the evening the visitors and their ladies enjoyed dinner in the beautiful building of the Dayton Engineers' Club. Messrs. Kettering, Handley-Page, and Steinmetz were the speakers, and the trend of their remarks was the necessity for the development of commercial aviation. Mr. Handley-Page recounted the developments in Europe along this line, while Mr. Kettering urged the production of a reasonably priced commercial machine, without which the public could not be expected to take up flying.

The last event on the program was a military ball given by the officers of the Field and held at the Miami Hotel.

The thanks of the Society are due to all the officers of the Air Service who contributed to the success of the day at McCook, which was acknowledged by everyone as a pleasurable as well as a profitable opportunity to show our interest in the magnificent work the Air Service is doing.

Rock Island Excursion

About forty of those attending at the Chicago meeting went to Rock Island on Thursday night, joining with some sixty engineers from the Tri-Cities Section for the events at Rock Island and Davenport. They started with a trip of inspection through the Rock Island Arsenal where Col. Harry B. Jordan, Commanding Officer, conducted the party through the modern shops in which

(Continued on page 499)

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

First Motorship with Double-Acting Two-Stroke-Cycle Engines

By R. DREVES

THE present article is of interest not only as describing an important project in motorship construction but also as illustrating the German method of going about the job of solving technical problems where experiments on models are not feasible.

The years 1909 and 1910 were signalized by a rapid growth of interest in Diesel engines, owing to the expiration of the life of the original Diesel patents. At that time the Augsburg-Nuremberg Engine Co. and the Blohm & Voss Shipbuilding Co. in Hamburg jointly formed a research corporation to develop large oil engines for ship use, and, in particular, for use on warships. It was decided at that time that the Diesel engine best suitable for this purpose would be of the double-acting two-stroke-cycle type.

As the first step in this development it was decided to build comparatively small units so as to keep within bounds the cost of experimentation. At the same time, in order to test the engine not merely on the testing stand but under actual conditions of operation, the Blohm & Voss Co. decided to lay down in its yards for for its own account a double-screw experimental freighter to be equipped with double-acting two-stroke-cycle engines. The actual work started in 1910—the ship to have an overall length of 106 m. (347.6 ft.) and a deadweight of 3083 registered tons.

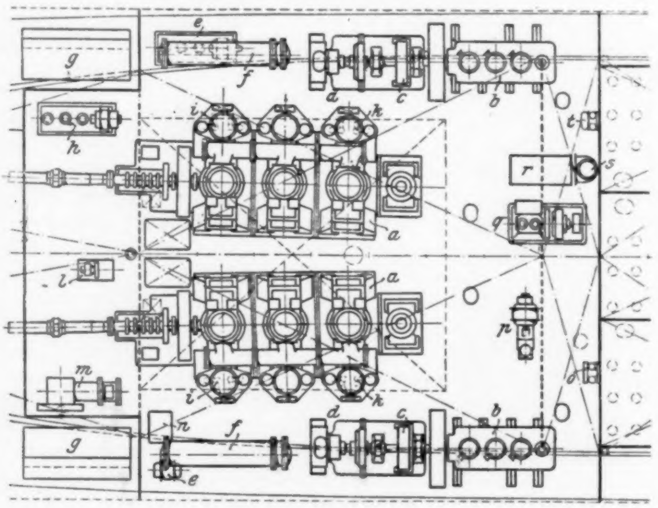


Fig. 1 Engine Room of the Motorship *Fritz*

The first three-cylinder unit could not be put into the ship because while on the test stand cracks appeared in the cylinders. Its engine was, however, used for experimental purposes and as a basis for the design of a new unit. This latter had working cylinders of 480 mm. (18.9 in.) bore by 710 mm. (27.9 in.) stroke, with an output at 120 r.p.m. of 830 s.hp. The fuel-injection compressor built as a three-stage unit was driven by a crank from the extension of the main crankshaft, an arrangement which since has become fairly universal. This compressor has bores of 510, 445 and 115 mm. (20, 17.4 and 4.55 in.) and a stroke of 350 mm. (13.75 in.).

The three scavenging pumps of 650 mm. (25.60 in.) bore and 500 mm. (19.6 in.) stroke were driven from the crossheads of the working cylinders, while the six-cylinder fuel pump of 11 mm. (0.43 in.) bore and 60 mm. (2.36 in.) stroke was driven by an eccentric from the camshaft.

Furthermore, the bilge pumps and fresh-water pumps for the piston cooling were driven by means of a rocking lever from the first and third cylinder.

In designing the engine the question of reliability was made paramount, while weight and cost of construction were secondary and even fuel consumption was treated as being subordinate to reliability. As regards weight, it was decided that the Diesel engine should weigh about as much as a steam engine of similar output. Because of this, not only the bearings but bedplates, foundations and other parts were made of unusually generous size. If it had been desirable to keep down the weight many parts

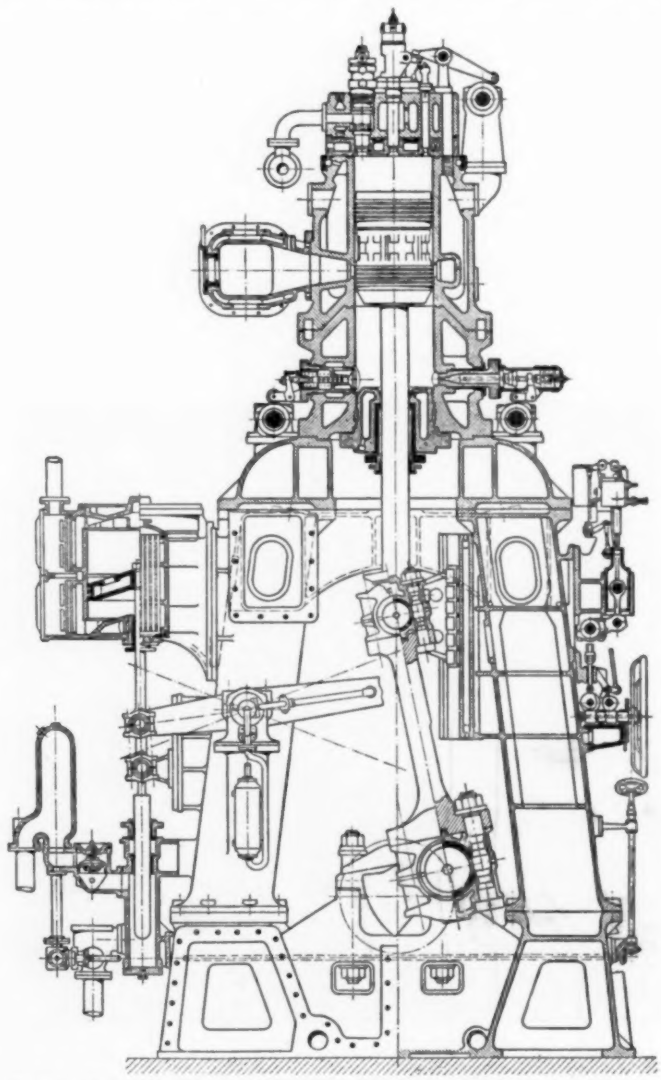


Fig. 2 Cross-Section of Main Double-Acting Two-Stroke-Cycle Diesel Engine

could have been made at least 50 per cent lighter. No effort was made to keep down the length of the engine since this was so small anyway that the size of the engine room was determined not by the dimensions of the engine but by the location of the auxiliary machinery, as may be seen from Fig. 1. This, for example, made it possible to design a crankshaft in the manner usual with marine engines, namely, in three parts with two bearings between each two crankshafts. This tended to make the loads on the bearings extremely light, which was further assisted by the fact that in

double-acting engines the variations of pressure on the bearings are more favorable, giving them a longer life than is the case with single-acting engines. As a result of this, it proved to be possible to operate the bearings just as in steam engines—without forced lubrication, and this, in its turn, permitted making the engines open-type and thoroughly accessible in all their parts, which was particularly desirable as it mad[illegible] to inspect the stuffing boxes on the piston rods. It may be mentioned in this connection that during the entire period of ve[illegible]xtensive series of tests these stuffing boxes have never given any trouble. Fig. 2 shows a cross-section of this engine.

The working cylinders are made up of two parts. At the bottom of the cylinder, which constitutes the upper part of the columns and reinforces it crosswise, is located the lower part of the double-acting working cylinder which is closed at the bottom by a special head.

In the upper head the valves are set in the usual manner and comprise one starting valve, one fuel-injection valve, two scavenging valves and one safety valve. In the lower cylinder head there are two fuel-injection valves, two scavenging valves, a starting valve and a safety valve.

The arrangement is such that the valves are easily accessible to the engine personnel and can be withdrawn in a very short time without disturbing any other part of the engine mechanism.

The starting valve is built as a balanced valve and is operated by compressed air. Fig. 3 shows the starting valve for the upper half of the double-acting cylinder. The valve opens with air admission to, and closes through air exhaust from, the air chamber over the distributing piston, the air being governed by means of the starting throttle. Each starting valve is equipped with two starting throttles located in the same housing, one being intended for forward and the other for reverse running of the engine. The needle of the fuel valve opens into the cylinder, but can be adjusted without trouble from the outside.

The working pistons are in two parts. The lower part is attached

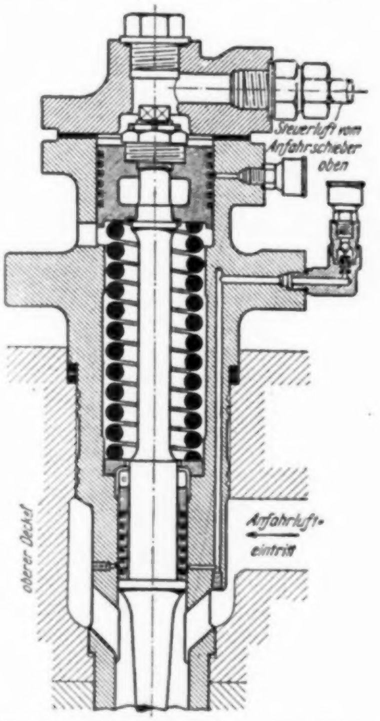


FIG. 3 STARTING VALVE OF THE UPPER PART OF THE CYLINDER OF THE DOUBLE-ACTING TWO-STROKE-CYCLE ENGINE

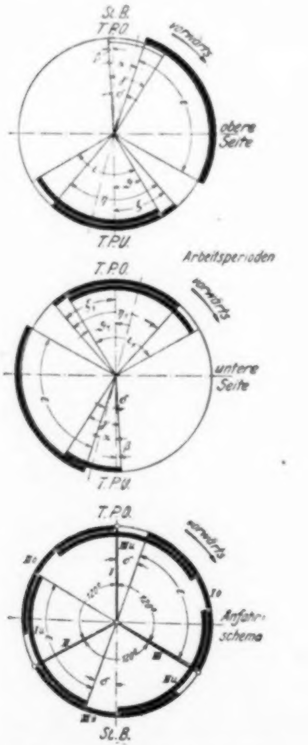


FIG. 4 VALVE DIAGRAMS OF THE DOUBLE-ACTING TWO-STROKE-CYCLE DIESEL ENGINE

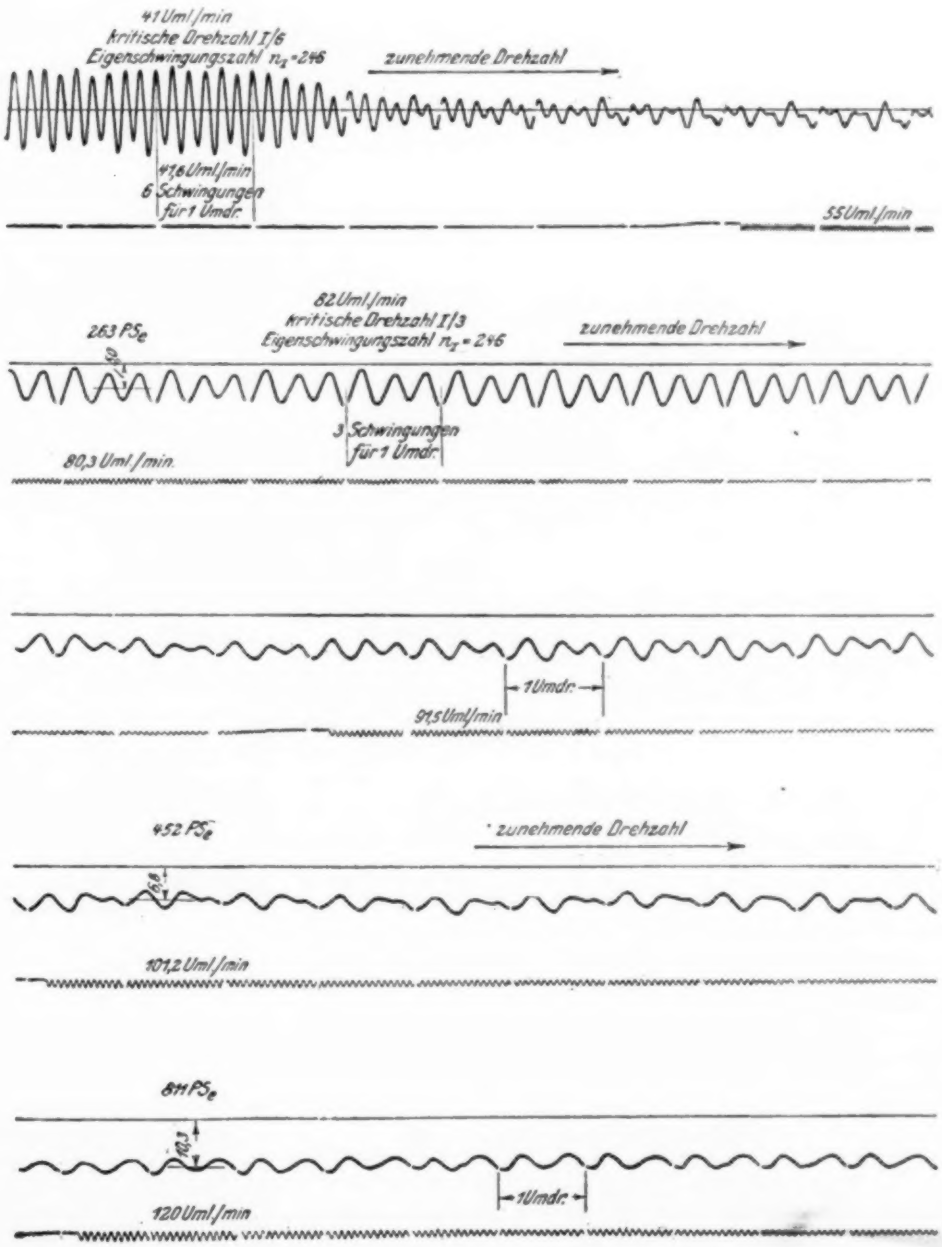


FIG. 5 TORSION DIAGRAMS OF THE RECONSTRUCTED DIESEL ENGINE TAKEN BY MEANS OF A FRAHM TORSION INDICATOR

to the piston rod and carries a cast-iron upper section from which it may be separated by sheet-iron disks, the volume of the combustion space varying with the number used. The piston in each half of the cylinder is equipped with five cast-iron rings held so as to make their rotation impossible.

The valves are operated by cams. The upper valve set is operated by means of a single camshaft, while in the lower set there are two camshafts—one in front and the other back of the cylinders, all three camshafts being driven by gear wheels in the same manner as other Diesel engines built by the company, generally referred to as "MAN," its German name being the Maschinenfabrik Augsburg-Nürnberg.

The engines were very extensively tested both on the testing stand and in the ship. Before the first of the two engines was put into the ship it was subjected to a test equivalent to six days of uninterrupted travel, then 12 hr. of maneuvering, 3 hr. of reverse

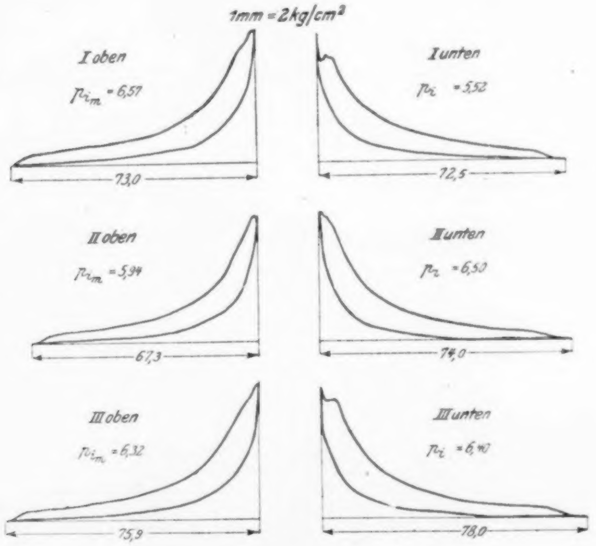


Fig. 6 Indicator Diagrams Taken During the Second Trial Run

running, and 4 hr. of slow-speed travel. The second engine was tested in the same manner. (It is not quite clear, however, how the first engine was tested in this manner *before* it was installed on shipboard.)

The fuel consumption proved to be 225 grams (0.48 lb.) per hp-hr. with an overall efficiency of 72 per cent. The mechanical efficiency, taking into consideration the indicated output of the scavenging pump and compressor, was 89 per cent. It would be difficult to expect anything better from a comparatively small engine. When the engine was tested on shipboard important disturbances appeared through the rise of oscillatory motions with amplitudes which previous experience did not lead one to look forward to. In fact, certain speeds of rotation could not be employed at all without endangering the entire installation and could be obtained only with unusually heavy fuel consumption. The conditions were made still worse through the fact that the cruising speed of 120 r.p.m. happened to be within the critical range of the engine. Important alterations had to be made in order to get away from this situation.

After the engine was rebuilt measurements were made by means of a Frahm torsion indicator developed in the meantime and some of the torsion diagrams are shown in Fig. 5. From these can be seen the uniformity of running at the higher speeds. At 82 r.p.m. and 41 r.p.m. are located the two critical speeds of the third and sixth order. Further measurements were carried out on submarine engines both on the testing stand and on board a submarine, and data collected in this way are now used by Blohm & Voss in the design of their commercial heavy-oil engines. So that while it is still impossible to compute the oscillatory disturbances which may arise at certain higher speeds, sufficient data are available to make it possible to design engines in such a manner as to keep on the safe side.

The first experimental run on the motorship *Fritz* was undertaken on the River Elbe in May 1915, lasted 8 hr. and was free from any trouble. The fuel consumption proved to be 160 grams per i.hp-hr. (0.35 lb.) with an average output of 1093 i.hp.

The next test run could not be undertaken until September 1919. During these test runs the diagrams of Fig. 6 were taken showing the operation of the upper and lower ends of the various double-acting cylinders.

In accordance with the Peace Treaty the motorship was surrendered to England. It is of interest to note that the firm of Blohm & Voss called the attention of the British Government to the fact that the ship was of a merely experimental character and that at least a few more sea trips ought to be undertaken to determine the reliability of the various apparatus. The firm therefore made a proposal to the British Government that a few more runs should be undertaken in the Baltic. The British Government accepted this proposition and in November 1919 an acceptance run was undertaken. The ship encountered very heavy weather but reached England safely.

Since that date the two German concerns working in coöperation have undertaken and executed the construction of marine engines of the type described here, but of very much greater dimensions. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 65, no. 18, Apr. 30, 1921, pp. 459–462, 18 figs., *dA*)

Centrifugal Casting Processes

HUME CENTRIFUGALLY MADE CONCRETE PIPE

DESCRIPTION of a process for the manufacture of concrete pipe by centrifugal deposition as carried out by a company in South Africa. The pipe is reinforced with steel and the first step in its manufacture is the preparation of the reinforcement. As the plant is located not far from the gold-mining district of the Witwatersrand, it is able to make use of the discarded mine-haulage cables for this purpose.

The cables are delivered at the pipe works in coils and are first degreased, which is necessary as cement will not adhere to any material that has a greasy surface. The grease is burnt out in a wood fire, the wire being somewhat annealed at the same time.

After a coil has cooled down it is unraveled with the help of specially designed machines. This is followed by spooling the wire, the spools being then transferred to the machine on which the reinforcement cylinders are made.

A spool of wire is placed on a spindle, set vertically, and fixed, a few feet from the machine. The end of the wire is drawn forward and threaded through a series of three pulleys on a traveling feeder, these pulleys serving to keep the wire tight. The feeder itself is part of the reinforcement machine, along the base of which it is drawn by chains in a direction parallel with the cage core.

The reinforcement or "cage" is built on a round horizontal core consisting of four radially collapsible sections.

The molds are two-piece cylinders made of galvanized iron and are greased inside to prevent the cement from adhering. The reinforcement is then inserted and the end caps bolted in position. These end caps are broad, flat rings, the inside diameter of which is the inside diameter of the pipe to be made, the desired thickness of the pipe wall being exactly secured by the use of rings or end caps of the proper dimensions.

The pipe-making machines each make six pipes in one operation, the duration of which may be anywhere from 12 to 20 min. according to the size of the pipe.

In making the concrete for low-pressure pipe, Pretoria cement is used with sand and specially selected $^1/_4$ to $^1/_2$-in. grit in the proportion of 2 to 2 to 1; for high-pressure pipes sand and cement are used in the proportion of 2 to 1. The material is prepared in rotary

mixers, from which it is discharged into a pair of barrows traveling on rails underneath the pipe machines.

The speed of the pipe machine during the process of shoveling the concrete into the rotary molds is set slow and all the workman has to do is to throw the concrete rapidly, a shovelful at a time, into the mold. When the molds have received sufficient concrete the speed of the machine is increased. This speed varies with the size of the pipe and, for instance, for a 4-in. pipe is 360 r.p.m., while for a 6-ft. pipe it is 48 r.p.m.

One of the important features about the Hume pipe is the great denseness of the material. The following tests have been made to prove this. An ordinary 12-in. mold without reinforcement was filled with concrete and rammed in by hand as tightly as it would go. In other words, the same process was followed as one might use to make a solid concrete column. The mold was then placed in the machine and rotated for a period at the speed required for the making of an ordinary Hume pipe. The mass was then examined and was found to have developed itself into a pipe with an internal diameter of $3^1/_2$ in., which would mean that the 12-in. column as originally made had a volume of air-filled spaces between particles equivalent to a pipe $3^1/_2$ in. in diameter and that by the centrifugal action this was packed solid.

The pipe has also a rather unusual joint. The end of each pipe is so molded that instead of a flat surface a groove of a peculiar shape is produced, this groove being such that its deepest portion lies toward the inner periphery of the pipe, while it becomes shallower as it reaches the outside periphery. When two pipes are brought together their edges enclose a cone-shaped space, the apex of the cone being toward the outside of the pipe, and this space is filled by the pipe layer with a special plastic compound.

A sleeve of concrete also goes over the joint and its inside diameter is a little larger than the outside diameter of the pipes. The annular space thus formed is filled with a mixture of sand and cement, which is calked or rammed into position exactly as lead is used for jointing iron and steel pipes. The practical effect of this system of jointing is that the greater the pressure of water in the pipes, the more resistant to leakage becomes the joint.

It is claimed that the Hume pipe never bursts and that when the pressure is increased beyond a certain point the pipe merely begins to "weep." If the pressure is further increased sprays of water appear, but there is no burst; moreover, when the water pressure is reduced to normal the pipe is just as efficient as it was before. In other words, the strain does not cause any deterioration. (*The South African Journal of Industries*, vol. 4, no. 3, March-April 1921, pp. 224–235, illustrated, *dA*)

NON-FERROUS CASTINGS IN SPINNING MOLDS

By Louis J. Josten

Description of a method for casting copper bands for large Navy shells by a centrifugal casting-machine process as used at the works of the George C. Clark Metal Products Company, Detroit.

The process appears to be one which requires a high grade of skill and knowledge at practically every stage. Beginning with the handling of the metal, it would appear that positive methods must be employed that will permit the band to be cast at the most desirable temperature, as otherwise the physical properties of the compound will not be right.

The metal is cast in down-draft melting furnaces of 3000 lb. capacity each, and from the furnaces is poured into ladles of a capacity sufficient for three bands. It is hauled to the casting room by means of an overhead trolley system and extra precaution is taken that the metal does not oxidize while on its way there.

The casting machine is shown in Fig. 1. Its principal parts are the die and die holder, the movable spout and the metal-pouring attachment. The holder is made of plain carbon-steel wire; the die or liner is a specially heat-treated forging. A hinged cover plate of the same diameter as the holder and having an opening large enough to accommodate the pouring spout is made to open and close on the side of the die and holder. It is said that the life of a liner is such that about 250 bands may be cast before it is burned out and replaced.

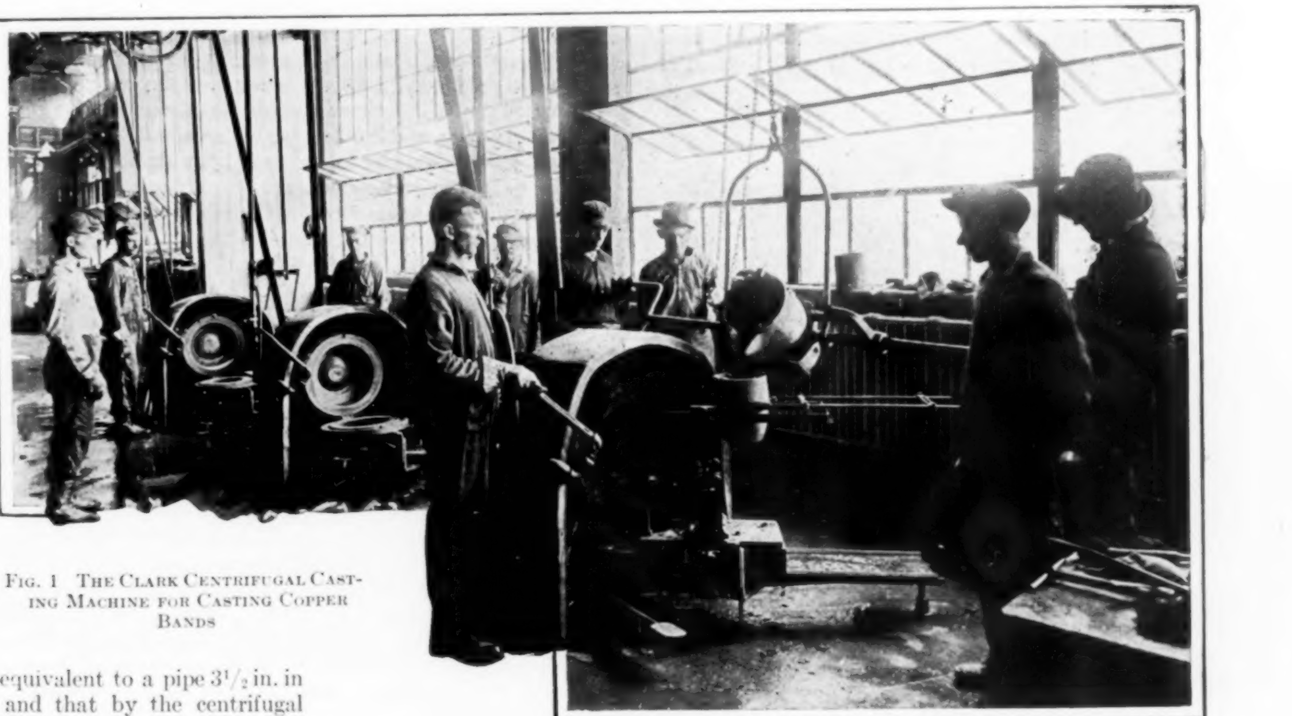


Fig. 1 The Clark Centrifugal Casting Machine for Casting Copper Bands

It is obvious that all revolving parts must be in absolute balance, as otherwise the band will not come out true. The metal is poured through the spout so arranged that it can move in and out of the die. Pouring is done by tilting the small crucible in the machine so that the metal will flow through the spout into the die. While the machine is still in motion the spout and crucible are pulled back out of the way, and when the band shows the desired color for annealing, a stream of water is turned on the band. After the band has sufficiently solidified and has received the proper annealing, the water pipe is taken back out of the way, the cover plate is unscrewed and the band removed from the die. After the band is cast it is necessary to keep the lip of the pouring spout clean as a certain amount of metal clings to its side and has to be removed by hand with a chisel. The bands themselves are then machined.

It is stated that the most successful bands made are of the larger

diameters, 10 in. and up, and that the percentage of rejected castings made by this process is small. (*The Iron Age*, vol. 107, no. 20, May 19, 1921, pp. 1289–1292, 4 figs. *d*)

TESTS OF CENTRIFUGALLY CAST STEEL

By Dr. Geo. K. Burgess

In an abstract on this subject printed on page 334 of Mechanical Engineering for May 1921, a statement was made that the distribution of carbon in the metal is not uniform, but the character of the lack of uniformity was not indicated.

In view of the importance of centrifugal casting as a recent development, Table 1, taken from the more complete publication

TABLE 1 HARDNESS AND CHEMICAL SURVEYS

Casting Number and Wall Thickness,	Zone[1]	Brinell	Sclero-scope	Carbon per cent	Manga-nese per cent	Silicon per cent	Sulphur per cent	Phos-phorus per cent	Nickel per cent	Copper per cent	Chro-mium per cent
No. 1	1	186	25.8	.44	.44	.47	.024	.011	2.33	.084	...
	2	186	24.9	.48	.44	.47	.030	.013	2.35	.089	...
3½ in.	3	187	25.0	.46	.44	.47	.032	.013	2.32	.085	.04
	4	187	25.2	.46	.44	.48	.032	.014	2.36	.094	...
	5	196	25.7	.50	.44	.47	.034	.015	2.39	.089	...
3A	1	160	22.3	.33	.54	.19	.022	.015	2.66	.051	...
	2	164	22.2	.32	.55	.19	.030	.014	2.67	.053	...
3 in.	3	167	22.4	.32	.55	.19	.032	.015	2.70	.051	.04
	4	167	22.6	.34	.57	.19	.034	.016	2.75	.055	...
	5	160	22.3	.34	.57	.20	.030	.017	2.70	.054	...
3I	1	158	21.9	.30	.55	.20	.031	.012	2.66	.062	...
	2	159	22.0	.30	.55	.19	.030	.013	2.67	.062	...
3 in.	3	158	22.0	.30	.55	.20	.030	.015	2.68	.067	.04
	4	156	22.5	.34	.57	.20	.030	.017	2.76	.068	...
	5	184	23.9	.35	.57	.21	.030	.018	2.70	.065	...
4	0	...	....	.16	.47	.27	.054	.045	....	....	...
	1	125	19.7	.16	.50	.29	.045	.033	....	....	...
	2	...	20.4	.16	.51	.28	.045	.033	....	....	...
2¼ in.	3	128	20.6	.17	.50	.28	.049	.037	....	....	...
	4	...	20.0	.18	.50	.29	.053	.038	....	....	...
	5	121	19.2	.21	.52	.29	.060	.043	....	....	...
	6	...	....	.18	.40	.22	.066	.059	....	....	...
5	1	249	63.5	.64	.56	.65	.033	.014	2.94	....	...
	2	...	60.6	.65	.56	.65	.032	.015	2.92	....	...
3¼ in.	3	248	58.0	.63	.55	.64	.029	.015	2.93	....	tr..
	4	...	55.5	.63	.55	.64	.031	.017	2.93	....	...
	5	245	57.0	.72	.60	.68	.033	.017	2.90	....	...
6	1	164	23.4	.32	.56	.19	.034	.015	2.69	.059	...
	2	166	23.4	.33	.56	.19	.035	.015	2.75	.058	...
3½ in.	3	161	23.4	.31	.56	.19	.039	.015	2.72	.059	.04
	4	167	23.8	.33	.57	.19	.032	.015	2.76	.064	...
	5	191	25.2	.35	.57	.19	.033	.016	2.81	.064	...
7	1	...	....	.22	.54	.26	.026	.013	....	....	...
	2	123	....	.21	.53	.25	.026	.014	....	....	...
½ in.	3	...	....	.25	.55	.25	.026	.016	....	....	...

[1] Zones numbered from outside to inside of casting.

of the paper by Dr. Burgess, is of interest, as it shows that throughout the main part of the body of the centrifugally cast tube the distribution of carbon and other alloying elements is very uniform indeed, and it is only in the inner ring, which may be from 1/32 to 1/16 in. thick, that there is an increase of the lighter elements such as carbon or phosphorus, due evidently to the classification produced by centrifugal action. (*Transactions of the American Society for Steel Treating*, vol. 1, no. 7, Apr. 1921, pp. 370–382, *eA*)

CENTRIFUGALLY CAST CAST-IRON PIPE

By Prof. Peter Gillespie

Description of the De Lavaud process of centrifugal casting of cast-iron pipe as carried on commercially in Canada.

The pipe is cast on the inside of a horizontal water-cooled rotating cylinder revolved on its axis by an impulse water wheel integral with itself and flared at one end to give the proper contour to the bell. The mold revolves in a cylindrical stationary casing and is supported at two points in its length by two pairs of friction rollers which are carried on the inside of this casing. In the manufacture of 6-in. water pipe the speed of revolution is about 550 r.p.m.

The molten metal is introduced into the mold by a cantilever spout which receives its supply from a tilting ladle operated by hydraulic pressure. The iron for the bell end is first supplied, immediately following which the casing and mold are moved backward by hydraulic means on horizontal ways away from the ladle and spout, thus enabling the latter to supply the metal continuously from the body of the pipe right out to the spigot end. The mold continues to rotate for perhaps 15 sec. after the last of the necessary iron has been supplied.

As it comes from the mold the iron is chilled and must be annealed. This annealing in a special furnace takes from six to seven minutes, after which the pipes are allowed to cool in still air.

Centrifugally cast pipes are lighter than sand mold pipes of similar bore, and, for example, in 4-in. size the standard C class weighs 23.3 lb. per ft. and the centrifugal pipe 15 lb.

The metal in centrifugally cast piping is of a dense, homogeneous character and the pipes are smooth inside and out. Tests were carried out by the writer at the University of Toronto on pipes and pipe material made by sand casting and spinning and it was found that roughly the tensile strength of the specimens from centrifugally cast pipe was 2.3 times as great as that for specimens cut from sand-mold pipes. In every other test the centrifugal modulus of elasticity was 2.3 times greater for machine-made pipe than for ordinary pipe, and a 6-in. pipe with walls 0.28 in. thick was found capable of sustaining an internal hydrostatic pressure of 1250 lb. per sq. in. without failure.

The pipe is manufactured in Canada by the National Iron Corporation, Ltd., Toronto. (*The Canadian Engineer*, vol. 40, no. 19, May 12, 1921, pp. 454–455, 4 figs., *d*)

STEEL-TUBE CASTING

Description of a process for the centrifugal casting of pipe in which the metal is melted electrically in the same mold in which it is subjected to the spinning process.

The process is carried on in four stages, the first consisting of casting the metal in bars of approximately the same weight and length as the final tube. These bars, together with such additional metal as is necessary, are placed into the mold which consists essentially of an outside steel shell, a refractory lining, and a graphite lining. The molds with the metal inside are closed airtight at both ends and placed in a rack where electric current is supplied to the terminals from a bus bar. They are left on the rack until the metal inside has thoroughly melted, and are then transferred to the spinning machine.

The spinning continues until the metal has solidified, the time varying with the kind of metal and to a certain extent with its external temperature. When the metal in the tube has set, it is allowed to cool until the contraction of the diameter of the tube is sufficient for it to be pulled out of the mold. It is then subjected to such heat treatment as may be necessary.

The advantages claimed for this process are its practically automatic character, permitting the use of unskilled labor; ability to control very strictly the temperature and composition of the metal, and the absence of gases in the mold. (*The Iron Age*, vol. 107, no. 20, May 19, 1921, p. 1300, 1 fig., *d*)

The Failure of Metals Under Internal and Prolonged Stress

AT A JOINT MEETING of the Faraday Society, the Institution of Mechanical Engineers, the Iron and Steel Institute, the Institue of Metals, the North-East Coast Institution of Engineers and Shipbuilders, the West of Scotland Iron and Steel Institute, and the Institution of Engineers and Shipbuilders in Scotland, held in London on April 6, the subject of failure of metals under internal and prolonged stress was discussed. Abstracts of several of the papers presented were printed in the June Survey Section. Excerpts from others follow.

The Prevention of Season Cracking in Brass by the Removal of Internal Stress, H. Moore and S. Beckinsale. In a previous paper before the Institute of Metals the writers showed that in 70:30 brass the internal stresses could be reduced sufficiently to prevent season cracking by annealing at low temperatures, and this without sensibly reducing the strength of the material or appreciably softening it. For the experiments whereby those results were obtained the writers used cups spun from fully annealed brass sheets and employed mercurous nitrate solution as the test

for the presence of injurious internal stress. The actual value of the stresses induced in the material by the spinning process could not be determined, and to that extent the experiments were incomplete. In the present paper the writers describe similar experiments conducted with specimens, the stresses in which, before and after annealing, could be calculated. Each specimen took the form of a strip of cold-rolled 70 : 30 brass, 6 in. long, 1 in. wide and either 0.02 in., 0.015 in., or 0.01 in. thick. Such a strip was clamped by its ends to a former block of 7 in. diameter. On the clamps being removed, the strip returned to the straight, showing that the elastic limit of the material had not been exceeded. The tension in the outer skin of the strip, when clamped, could therefore be calculated from the usual bending formula $p = Et/2r$. The strips, clamped to the former, were annealed at various temperatures for various lengths of time, and, on release, were found in all cases to assume a circularly bent form. If the radius assumed were r_1, then the stress in the material, after annealing and before release from the block, would be given by $p_1 = Et\ (r_1 - r)/2r_1r$. In this way the reduction of the initial stress effected by the annealing could be evaluated. Full data giving the results of the experiments are to be found in the original paper. In general the rate of reduction of the stress was found to increase as the annealing temperature rose, but in all cases it showed a marked slowing down after about one-half or two-thirds of the initial stress had been removed. For a brass of given hardness the higher the initial stress the higher was the stress remaining after a given heat treatment, while for a given initial stress and a given treatment the stress remaining after annealing decreased as the initial hardness of the material increased. The reduction in the internal stress is attributed to a slight plastic flow which occurs in the metal and which increases in amount with an increase of the annealing temperature, the duration of the annealing process and the magnitude of the initial stress. It is said that season cracking of brass can be eliminated in all cases by the application of a suitable low-temperature annealing to the manufactured article after the final cold-working operations. (*The Engineer*, vol. 131, no. 3408, Apr. 22, 1921, p. 427, *e*)

INTERCRYSTALLINE CRACKING OF MILD STEEL IN SALT SOLUTIONS, A. J. Jones. Experimental study of the action of salt solutions on stressed mild steel. A number of riveted plates were prepared, the rivet holes in some cases being punched and in others drilled. The rivets were heated only to the minimum temperature necessary for the work, in order that comparatively high stresses might be induced. The plates were placed in a solution consisting of four parts of calcium nitrate to one part of water, at a temperature of about 145 deg. cent., and were examined at intervals. No corrosion or cracks could be detected on the outside surface of the plates after 23 days, but in 28 days two of the plates with punched rivet holes and one of the plates with drilled rivet holes showed a large number of distinct cracks. The other plates, including four with $^1/_2$-in. rivets, showed no cracks after 74 days; a number of these were then cut up, but no cracks were found on the inner surfaces. Plates produced in the same way, but normalized after riveting, showed no signs of cracks after 74 days in the calcium nitrate solution. The cracks produced as described above were examined and in every case were found to be intercrystalline. The microstructure of the plates was normal.

A second series of experiments was carried out on strips of mild steel $^1/_4$ in. thick, 1 in. wide and 4 in. long. Bolt holes were formed in pairs near the ends of the specimens, and the strips were tightened up and bent until their ends met. In calcium, sodium and ammonium nitrates and in potassium hydroxide the specimens developed intercrystalline cracks in from two and a half to five and a half days. No cracks were found after a number of days in specimens placed in sodium carbonate, ammonium sulphate, calcium chloride and a fused mixture of sodium and potassium nitrates. Specimens of bent plate identical with the above were annealed for one hour at 200, 300, 400, 600, and 900 deg. cent., respectively, after assembling and previous to placing in calcium nitrate and potassium hydroxide solutions. The plate annealed at 200 deg. cent. cracked in the calcium nitrate solution in 7 days. The specimen which had been immersed in the fused sodium and potassium nitrate mixture at 250 deg. cent. for 29 days cracked in the calcium nitrate solution in $8^1/_2$ days. The plate annealed at 300 deg. cent. cracked after 11 days in the calcium nitrate solution. None of the plates annealed at higher temperatures had cracked after 50 days. Two specimens similar to one another but bent through a smaller angle than the standard form cracked in 8 days and 6 days in calcium nitrate and potassium hydroxide solutions, respectively. (*Engineering*, vol. 111, no. 2885, Apr. 15, 1921, pp. 469–470, 7 figs., *e*)

ACTION OF INTERNAL STRESS ON TOOL STEEL, J. Neil Greenwood. Discussion on the failure of metals through the action of internal stresses, with special reference to tool steels. The opinion is advanced that internal stress falls into two main classes, namely, distortion of the equilibrium space lattice by cold-working, and suppression of an allotropic change as a result of rapid cooling. In the case of pure iron the change from the α form to the γ form is accompanied by a volume contraction of about 0.5 per cent. With the introduction of carbon another change takes place due to solution of iron carbide at and above 725 deg. cent., accompanied by transformation of the solvent iron to the γ state. This is associated with a volume change, which increases with the carbon content. The expansion due to solution of the carbide, however, does not equal the contraction due to the formation of γ iron even with 1.5 per cent carbon present. With 0.8 per cent carbon or more the contraction is approximately half of that due to the "α to γ" transformation in pure iron. The compressibility of steel is 0.62×10^{-6} per megabar, or 0.945×10^{-4} per ton per sq. in. In other words, a pressure of one ton per square inch causes a diminution in volume of 0.009 per cent; so that an external pressure of at least 50 to 60 tons per sq. in. would be required to cause a contraction equal to that resulting from the transformation from the α form to the γ form. A contraction of volume also occurs when α cementite is transformed into β cementite at about 200 deg. cent., but this contraction is very slight and only becomes appreciable in comparison with the other changes when there is about 2 per cent carbon present. In the process of hardening carbon steel internal stresses may be caused by the retention of iron in the γ form with a tendency to revert to the α form or by the suppression of the carbide phase change when this compression is accompanied with decrease in volume, or by the completion of the carbide phase change in the interior of the mass. (*Engineering*, vol. 111, no. 2887, Apr. 29, 1921, pp. 535–537, 1 fig., *g*)

NOTE ON PHOSPHOR-BRONZE BARS, John Arnott. Examination of properties and behavior of phosphor-bronze hexagonal bars, presumably either cold-rolled or cold-drawn. Tensile tests on one bar gave: Yield point, 36 tons per sq. in.; tensile strength, 37 tons per sq. in.; elongation, 22 per cent on 2 in.; and reduction of area, 67.9 per cent. A similar bar was annealed at 600 deg. cent. for half an hour. Tensile tests on the annealed bar gave: Yield point, 7.2 tons per sq. in.; tensile strength, 21.12 tons per sq. in.; elongation, 81 per cent on 2 in.; and reduction of area, 80 per cent. It was evident that the very high yield point and tensile strength of the material could only have been obtained by excessive cold work. To prove this, pieces of the cars were immersed in mercurous nitrate solution. Cracks began to form in three minutes, and after an hour the bars showed both transverse and longitudinal cracks. The material, as received was apparently quite ductile. (*Engineering*, vol. 111, no. 2885, Apr. 15, 1921, p. 474, 2 figs., *e*)

THE SPONTANEOUS CRACKING OF THE NECKS OF SMALL-ARM CARTRIDGE CASES, W. C. Hothersall. Experimental study of the cause of cracking of the necks of small-arm cartridge cases during storage. Mercuric chloride and ammonia tests revealed the fact that the bulleting and necking operations, in which the mouth end of the case is swaged down to fit the bullet diameter, are most likely to originate the stresses causing the cracks. Of twenty cases placed in an acidified solution of mercuric chloride sixteen cracked immediately and all within forty-eight hours, while of a similar number suspended in ammonia gas all cracked in twenty-four hours. The cracks were similar to those which have been observed to form spontaneously, that is, mainly longitudinal, beginning at the mouth of the case and extending up the neck toward the shoulder. The presence of circumferential stress in the necks was confirmed by

withdrawing the bullets and measuring the diameter of the case close to the mouth. It was found that the necks were expanded by the withdrawal in some instances and were contracted in others. The former cases did not crack in mercuric chloride, while the latter did. Evidence was also found to the effect that the indenting process, under which the bullet is fixed in position by indenting the neck at three point to the circumferential groove in the bullet, can set up local stresses which will later cause the formation of cracks. The hardness of the neck of the case also influences the cracking, and it is possible that mercury derived from the fulminate of the cap composition acts as an accelerator. (*The Engineer*, vol. 131, no. 3408, Apr. 22, 1921, p. 427, *e*)

Experiences of Season Cracking During the Great War, Owen W. Ellis. Account of investigation undertaken during the war at the Metallurgical Laboratory of the Royal Laboratory Department of the Ordnance Factories, Woolwich, with a view to preventing season cracking of brass rods. After numerous experiments it was found that annealing for two hours at from 200 to 300 deg. cent. was quite sufficient to remove all internal stresses which would be likely to develop cracking. Since, however, the required mechanical properties of the material would not be affected by annealing at 400 deg. cent. and because annealing at 350 deg. cent. for about half an hour proved to result in the same beneficial effect as the annealing for a longer time at the lower temperature, this latter method of annealing was finally adopted as the standard workshop practice. (*Engineering*, vol. 111, no. 2885, Apr. 15, 1921, p. 474, *e*)

Short Abstracts of the Month

AERONAUTICS

Pulsating Wings for Aeroplanes, Harry Harper. An attempt to describe the theory and action of the wing said to have been invented by Prof. Raimund Nimfuhr of Vienna. It is stated that a full-sized load-carrying aeroplane is to be built and that the venture is to be financed by American capital.

In the Nimfuhr method an attempt is made to imitate the pulsating action of an insect's wing and it is stated that the Nimfuhr wing is hollow with air bags inside, the underneath section of the wing taking the form of a flexible membrane. This membrane can be set beating or pulsating by the action of pneumatic pumps which alternately fill or empty the air bags in the wing. These pulsations, extremely rapid, act powerfully on the cushion of compressed air which, in flight, is formed beneath the plane, and it is claimed that they will not only sustain but also propel a machine forward through the air, the air screw being eliminated entirely.

The Nimfuhr wing is also provided with flexible extremities at both ends, which, by pneumatic action, can be made to extend or contract in imitation of the "reefing" of a bird's wing. (*Motor Transport*, vol. 32, no. 843, Apr. 25, 1921, pp. 442–443, *d*)

[It may be mentioned in this connection that an unsuccessful attempt to build an aeroplane with pulsating wings was made in 1908 by a Russian engineer, Tatarinoff, working with the Russian War Dertm ent, in which the pulsations of the wing were to be produced by means of springs.]

AIR MACHINERY (See also Pumps)

Despatching Messages on Warships Pneumatically

Pneumatic Transmission of Messages on Warships. Description of pneumatic-despatch equipment extensively used on British warships.

Fig. 1 shows diagrammatically the layout of a ship installation. There are two electrically driven pumps situated respectively in the fan room and on the lower deck, and controlled from the main and auxiliary wireless-telegraph offices. Each valve has a reversing valve fitted above the silencers, by means of which the message pipes are put into connection either with the suction or pressure sides of the pipe, so that the message carriers may either be drawn from the far end of the tube or propelled in the opposite direction.

On the suction side there is an intake consisting of a simple bell-mouthed casting covered with wire gauze at the open end. The silencers are galvanized steel vessels with the internal baffle plates and are introduced to eliminate the pulsations of the air and deaden the sound of the exhaust.

The pumps in smaller installations have a vertical single-acting cylinder of 6 in. bore by 4 in. stroke running at 500 r.p.m. and driven by a $1^1/_4$-b.hp. motor. In larger installations horizontal pumps of a somewhat different type are used.

The brass tubes in which the condensers or carriers travel are of $1^1/_2$ in. internal diameter and are made in lengths of about 15 ft., the bands being of standard radius of 5 ft. with a minimum radius of $1^1/_2$ ft.

The type of carrier employed has an end pad of hard felt and a body of fiber. A light steel finger spring is fitted inside to prevent the papers being carried from falling out. The felt pad fits the tube and forms a piston against which the air pressure works.

The layout of Fig. 1 shows that a single transmission tube is carried from the installation in the main wireless-telegraphy room to the bridge, and that tubes are carried from the auxiliary wireless-telegraphy room to the main wireless-telegraphy room and

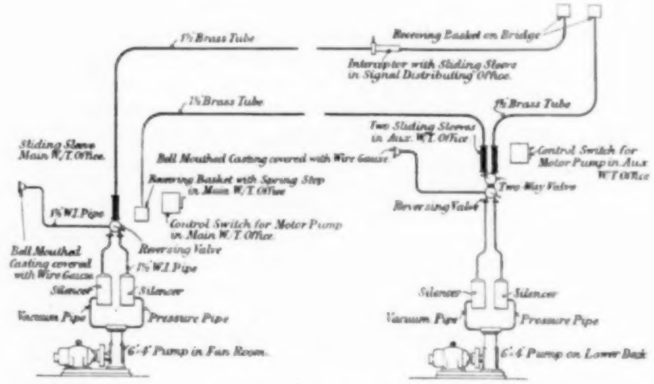


Fig. 1 Pneumatic Transmission of Messages on Warships (Diagrammatic Layout)

the bridge. On the tube leading to the bridge there is an interceptor in the signal-distributing office which consists of a sliding sleeve with a celluloid window and a valve or stop worked by a handle so that the carriers may either be stopped or allowed to pass through as desired.

The whole of this pneumatic-dispatch arrangement is simple and there is little or nothing to get out of order. It was very quick in operation and the time of transit on the longest tube on board ship is rarely more than 10 sec. (The speed at which the carriers travel in the tubes is approximately 30 m.p.h.). The original article describes also some of the secondary details of this apparatus. (*Engineering*, vol. 111, no. 2888, May 6, 1921, pp. 548–549, 10 figs., *dA*)

Pressure Losses in Compressed-Air Piping. Data of German experiences with various type of packing for compressed-air piping, taken from an investigation by a commission appointed by the German Board of Trade.

The test was made on a holiday. The piping of a large mine installation about 22 miles long with an average diameter of about 5 in. was kept under a uniform pressure of 6 atmos., all the underground workings being shut off. To maintain this pressure a compressor had to work continuously at 48 r.p.m., delivering roughly 3000 cu. ft. per min., which compensated for the leakage in the line.

As the consumption of the plant during the main shift amounts to 420,000 cu. ft. of free air, the loss due to leakage would be on an average of 30 per cent of the air delivered. A large part of this loss is attributed to the use of substitute packing instead of the standard rubber packing, as has been proved by additional tests. In these the air piping (60 ft. long, 3 in. in diameter, with 15 flange-packed joints) was put under the pressure of 6 atmos. The piping itself was absolutely tight and the pressure conditions in the line were recorded automatically. In these tests paper rings soaked in linseed oil and rubber rings were used for packing joints, with

the result that with an initial pressure in all cases of 6 atmos. the pressure with both plain paper rings and paper rings soaked in linseed oil at the end of 570 min. was 1 atmos., while with rubber rings the pressure from the same level only fell to 1.5 atmos. at the end of 1298 min., at which time the test was discontinued.

This would indicate that in the case of an installation of the size of the one tested the saving effected by using rubber packing rings is very material, indeed, and that the subject of packing rings is worthy of very serious attention. (Translated from the German engineer's report—source not specified. *The Compressed Air Magazine*, vol. 26, no. 5, May 1921, pp. 10092, *ep*)

FORGING

Friction Drop Stamp with Twin Brake Drums for Lifting and Holding Up

Twin-Drum Friction Lifter for Drop Stamps. With all its advantages the ordinary friction drop stamp has to overcome the handicap of considerable consumption of power together with heavy wear of brake linings. The new type built by a British concern is claimed to overcome some of these troubles through having two brake drums, one for lifting and one for holding up. As shown in Fig. 2, the flywheel is connected to the main shaft which runs at a speed from four to five times that of the ordinary lifter shaft. Connected to the same shaft is also a small central pinion of an epicyclic gear, the idlers of which mesh with an internal gear fixed to the rim

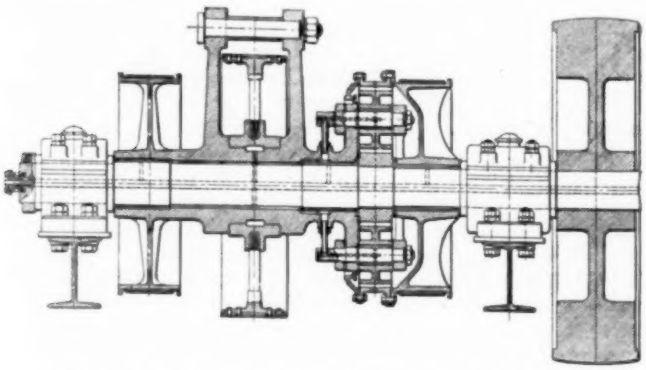


Fig. 2 Twin-Drum Friction Lifter for Drop Stamps

of a band-brake drum. The idlers themselves are mounted on a plate which is integral with the lifter, arms and pulley and also with the second band-brake drum seen on the left.

As regards the action, normally the central pinion revolves and the epicyclic gear causes the band-brake drum for the lifting movement to revolve also freely. If, however, this be arrested by the application of the right-hand brake, the idlers themselves revolve round the main shaft carrying the lifter, arms and pulley. The tup is held up by applying the band brake to the left-hand drum. The arrangement of the device is such that during holding up the only power used is that absorbed in gearing and the friction of the shaft and sleeve, whil no power is absorbed by slipping brake linings.

The design of the brake requires so little power to operate it that hand power can be employed without the introduction of any multiplying gear. The major portion of the braking load is taken on the brake drum attached to the lifting arms, so that the usual severe retarding loads on the gearing and motor are practically eliminated and the fluctuation of the load on the motor is greatly reduced. This is confirmed by data of tests given in the original article.

The brake linings used are pure asbestos and no water cooling is employed. (*Engineering*, vol. 111, no. 2889, May 13, 1921, pp. 584 and 588, 6 figs., *d*)

FUELS AND FIRING

Protection of Pulverized-Coal Plant from Dust Explosions and Fires, L. D. Tracey. Article based largely on data collected by the Bureau of Mines. Only the more important parts can be abstracted here.

The author, who is coal-mining engineer of the Pittsburgh Experiment Station of the U. S. Bureau of Mines, believes that it is practicable to install a vacuum-cleaner system in a coal-pulverizing plant, by means of which all parts of the building in which dust is liable to settle may be reached and cleaned. This has been done in some of the coal-crushing plants in France and Germany, and, in a few instances in our own country. Dust should never be brushed or swept up without first being thoroughly wetted down, and this applies not only to the pulverizing plant but also to the industrial portion of the operation.

The author strongly emphasizes the fact that accumulated dust and clouds of fine coal dust are highly dangerous when in close proximity to an open flame or mass of hot metal.

Excessively high drying temperature may result in explosion; moreover, as the author points out, coal dried at an abnormally high heat contains more moisture than when dried at a temperature of from 100 to 150 deg. fahr.

As regards some of the fires in the coal-conveyor lines between the bins and the furnace, the author believes that they oftentimes are due to spontaneous combustion in the storage bin. The coal in the bin becomes heated almost to the ignition point and the air current conveying it to the furnace supplies enough additional oxygen to bring it to incandescence. Because of this, whenever a plant has been shut down for a few days an examination should be made to ascertain the temperature of the coal in the bins before any pulverized coal is delivered to the transport lines.

Fine coal at a temperature of above 150 deg. fahr. should never be stored in a bin because of its liability to spontaneous combustion, and whenever a plant is to be shut down for a few days all storage bins should be emptied if possible. In the direct system of using pulverized coal the pressure of the distributing air should always be maintained well above that of the air supply for combustion purposes. Other recommendations of a practical nature are given in the original paper. (Paper read before the Engineers' Society of Western Pennsylvania, April 5, 1921, in Pittsburgh. Abstracted through *Coal Age*, vol. 19, no. 17, Apr. 28, 1921, pp. 746–749, *gp*)

INTERNAL-COMBUSTION ENGINEERING (See also Machine Parts)

Large British Gas-Driven Blowing Engine

1300-Hp. Gas-Driven Blowing Engine. Description of an engine to be operated on blast-furnace gas as built by aprominent British concern.

The power cylinders are 41.34 in. in diameter by 47.25 in. stroke and the bore of the air cylinder is 93.3 in., the engine being intended to deliver 30,000 cu. ft. of free air per minute. With the air compressed to 10 lb. per sq. in. normal blast pressure, the full load amounts to 1335 b.hp. The engine is chiefly interesting for the refinements of design which it embodies.

To eliminate casting and expansion stresses the power cylinders are cast in two halves and these are forced by hydraulic pressure over a cylinder liner of special cast iron and then bolted together The water space is closed by a jacket casing of mild steel plate made in two halves, and a rubber joint between the jacket and the cylinder casting permits of relative motion caused by unequal expansion without stressing the cylinder castings.

The exhaust-valve box and valve seat (Fig. 3) consist of a separate outer casing and inner casing and valve seat, all of which are water cooled. The exhaust-valve seat is in the form of an inverted U-shaped ring of hard cast iron and easily renewable. The joint between the valve seat and the top of the inner casing is in the form of two concentric spigoted circular rings and is made tight by copper joint rings, the whole insuring efficient water cooling and ease of access for inspection.

The arrangement of the joint between the exhaust-valve box and the cylinder is such that any leak of gas at this joint or any leak of water at the joint of the valve seat becomes immediately visible, which is important as a leak in this joint may lead to cracking of a cylinder if allowed to continue.

The valve arrangement is somewhat different from usual, the inlet valve consisting of a main inlet valve and a gas valve flexibly attached to the spindle of the former; this permits both valves to close tightly, even if the seatings are worn unequally.

The pistons are water-cooled and have coned faces stiffened by pairs of internal diagonal ribs. Coned nuts are also provided at each side of the piston to permit of longitudinal adjustment so that the piston rings may work exactly edge and edge with the ends of the liner when running. Both pistons and piston rods are water-cooled, the cooling water being supplied at about 40 lb. pressure. The cooling water (Fig. 4) enters a bracket placed on the foundation below the middle distance piece. From this it passes by two short swiveling pipes into one of two pairs of long pipes, by which it is led up to the intermediate crosshead. Thence it passes by bent pipes, one portion flowing along the annular space between the piston rod and the internal pipe, through the piston and back by the internal pipe to the intermediate crosshead, from which it passes out into the swinging leg on the other side of the engine. The other portion of the water supply passes in a similar way through the second piston and rod.

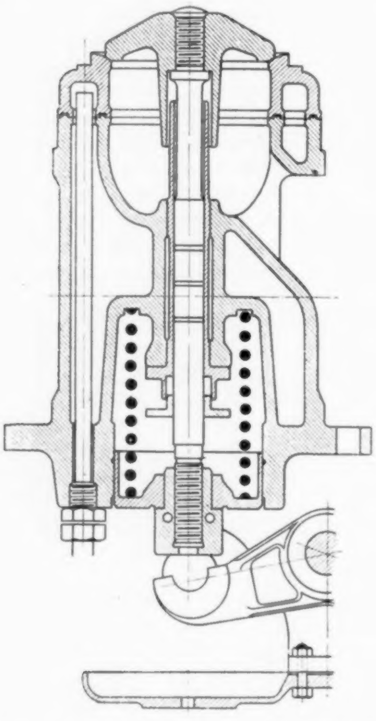


Fig. 3 Exhaust Valve of British 1300-Hp. Gas-Driven Blowing Engine

The cylinder barrels, covers, exhaust boxes and exhaust-valve seats are cooled by low-pressure water, while for the high-pressure piston water there are independent centrifugal pumps. The water from the pistons, cylinder jackets, covers, exhaust boxes and exhaust valve seats is discharged by separate pipes into open tun dishes mounted on the engine, so that the discharge from each part can be independently inspected, and the quantity and temperature individually controlled. (*The Engineer*, vol. 131, no. 3409, Apr. 29, 1921, pp. 451–454, 8 figs. and a 2-page supplement containing two more figures, *d*)

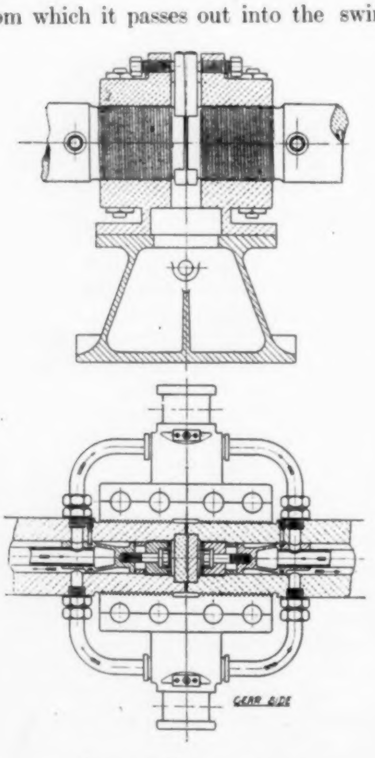


Fig. 4 Cooling-Water Arrangements for 1300-Hp. Gas-Driven Blowing Engine

A Unique Two-Stroke-Cycle Engine

"Silent Record" Internal-Combustion Engine. Description of an engine built by a British concern and working on somewhat unconventional lines. Essentially, the engine is a two-stroke cycle. Fig. 5 shows the arrangement of a two-crank engine. The cranks are at 180 deg. to each other and are connected to the charging-pistons C and D. These large pistons carry above them four working pistons A_1, A_2, B_1 and B_2. As the working pistons are about half the diameter of the charging pistons, the net area of the latter is about equal to that of the former. There is also a piston valve worked by the eccentric E. The action is as follows: On the down stroke the pistons C and D draw in explosive mixtures which are compressed on the up stroke and delivered to the inlet ports at the bottom of one of the working cylinders, the exhaust escaping through exhaust ports at the bottom of the other cylinder. The charging cylinders do not supply the working cylinders directly above them but those above the opposite crank, i.e., C supplies B_1, B_2 and D supplies A_1, A_2.

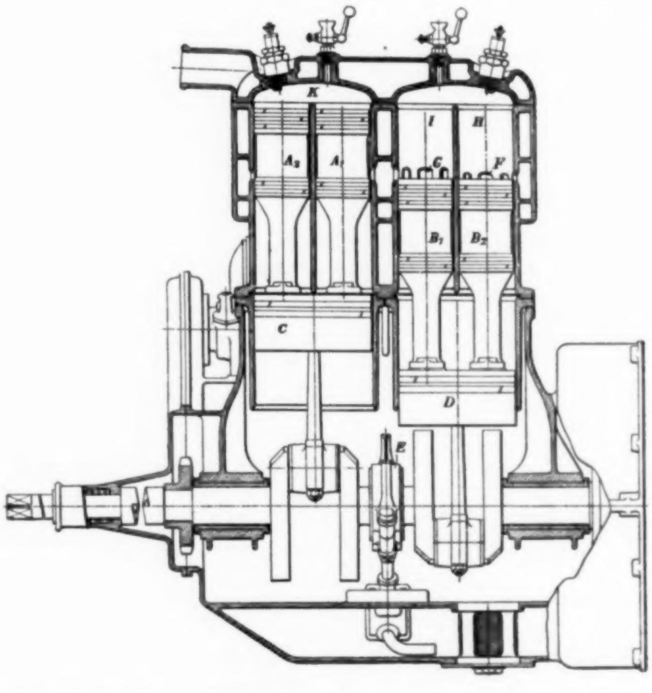


Fig. 5 "Silent Record" Two-Cycle Engine of Unconventional Design

Taking Fig. 5 in the position shown, the pistons A_1, A_2 have compressed the working charge into the combustion chamber K ready for firing. The charging piston C has also drawn in a charge and slightly compressed it in the space between the pistons. The pistons B_1, B_2 have finished their working stroke, and B_1 has fully uncovered the exhaust port G while B_2 slightly later uncovered the inlet port F. The piston valve now allows the charge compressed by the charging piston C to flow through the inlet port F into the cylinder H, from which it flows across the combustion chamber and down the cylinder I, pushing the exhaust out of the port G in front of it.

The charge in the combustion chamber K is now fired, and the pistons A_1, A_2, descend. As they do so the piston valve puts the space above C into communication with the carburetor and allows new mixture to be drawn in, while it puts the space above D into communication with the inlet port uncovered by the piston A_2. The charge in H and I is compressed and fired at the top of the stroke, while the pistons A_1, A_2, uncover exhaust and inlet ports corresponding to F and G, and the cycle recommences.

As compared with the ordimary two-stroke-cycle engine, the advantage of the design described above lies in the fact that crankcase compression is not used and also that positive distribution of the mixture to the charging cylinders is secured. It is also claimed that a more complete stratification is obtained.

The engine shown has four working cylinders equivalent to two cylinders 3 in. by $3^1/_2$ in., and develops 10 b.hp. at 1600 r.p.m. (*Engineering*, vol. 111, no. 2888, May 6, 1921, p. 565, 2 figs., *d*)

MACHINE PARTS

Aluminum Pistons. Frank Jardine and Ferdinand Jehle, Mem. Am.Soc.M.E. Discussion of performance and design of aluminum pistons.

According to the authors the most important function which the piston performs is that of converting heat into mechanical energy. Providing a path for some of the waste heat is a secondary duty, and it is of the utmost importance that the performance of this secondary duty interferes little or none with the performance of the first. Unfortunately, up to the present time there has been interference. The heat passing through the piston causes such undesirable effects as self-ignition of the charge and excessive expansion of the skirt which necessitates a large clearance when the piston is cold. The clearance trouble is aggravated when aluminum is substituted for cast iron, because of the greater expansion of the former.

As regards the design of aluminum pistons, the authors point out that it was Col. E. J. Hall who arranged the piston so as to provide a good path for the flow of heat from the head of the piston to the water jacket, but his design, while successful in aviation motors, did not prove adaptable to automobile engines.

The authors give their own formula for the head thickness of aluminum pistons.

The most interesting part of the paper, which, unfortunately cannot be abstracted owing to lack of space, reports tests in which the actual temperatures in pistons in operation in an engine have been measured at various speeds and horse-power outputs.

From these tests it was found that piston temperatures, especially those of the head, were very susceptible to changes in fuel consumption. Also, it was discovered that changes in cooling-water temperatures brought about a marked difference in the piston temperatures. Much of the heat was found to leave through the rings and the temperature immediately below the rings was found to be several hundred degrees lower than the head temperature. This brings up an interesting discussion of the influence of the temperature of the piston head on the expansion of the skirt, in addition to the thermal expansion due to individual temperature of the skirt. In fact, the authors come to the conclusion that separating the head from the skirt, in so far as this can be done mechanically, would relieve the skirt of mechanical expansion in certain directions and permit using a smaller clearance than would otherwise have been necessary. (*Journal of the Society of Automotive Engineers*, vol. 8, no. 5, May 1921, pp. 397–403, 9 figs., *ge*)

MACHINE TOOLS

Machine for Cutting Double-Helical Gears

Sykes Double-Helical-Gear Generator. Description of a gear generator based on the principle that the cutters take the form of pinions in gearing contact with the wheel being cut, and, with the latter, are rotated during the process of generation. The reciprocating motion given to the cutter is combined with the helical movement in order to secure teeth set at the required angle, in this instance the standard angle of 30 deg.

The reciprocating motion of the cutters across the face of the work is combined with two other movements. The first of these is an oscillating helical movement to make the cutters follow the lead of the gears to be cut, while the second is a continuous revolution to keep the cutters in unison with the revolution of the work blank. In modern types of Sykes generators the first movement is obtained with the bars and guides all to one side, one set having a hollow spindle through which the other is passed so that the guides can be placed close together on the left side of the machine.

The large guides and cast-iron housings with their two guiding faces are shown in Fig. 6. The fixed member is held in each case in a revolving housing and the recipreoating members work to and fro in the same elements. This design permits of both members being machined in exactly the same way. The fixed part is in two sections, the joint between the two being straight and in line with the axis. This enables wear to be taken up, one section being fixed and the other capable of adjustment longitudinally.

The continuous revolution of the cutter is obtained by large indexing worm wheels driven by worms on vertical spindles. In order to obtain the greatest accuracy of pitch the two indexing worm wheels are made as large as possible.

The cutters have to register correctly together, which is insured by means of two toothed clutches. The work is set up to the cutters until they just mark it and then they are adjusted by the vertical worms, the clutches being afterward secured down so that the driving gears are engaged again.

The following is said to be a typical example of marine turbine gears cut on this machine: Transmitting 2500 hp. with the primary pinion running at 4800 r.p.m., the smallest pinion of the set was of 5 in. diameter, 14 in. face and 5 diametral pitch, while the largest was 50 in. in diameter, 18 in. face and 3 diametral pitch. A 0.5 per cent carbon steel pinion of 14 teeth 5 diametral pitch and 8 in. wide can be cut in 60 min. Wheels of cast iron of 5 diametral pitch, 6 in. wide and 45 in. in diameter, take 7 hr. Cast-steel wheels 50

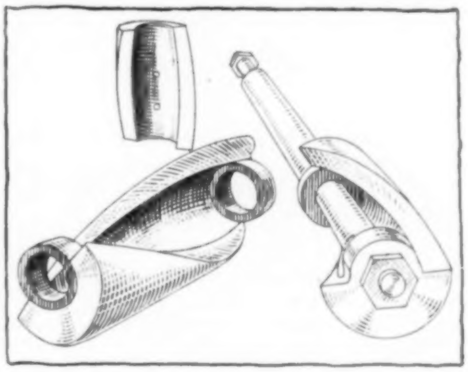


Fig. 6 Helical Guides for Cutter Spindles in the Sykes Double Helical-Gear Generator

in. in diameter, and of 16 in. face and 3 diametral pitch are cut in 14 hr. Rolling-mill pinions integral with 9-in. shaft, of 0.7 Mn and 0.5 per cent carbon steel, 25 teeth of $1^3/_4$ in. pitch, take about 9 hr. each; 48-in. turbine reduction gears with 18 in. face, of a maximum degree of accuracy, take about 24 hr. each. (*Engineering*, vol. 111, no. 2887, Apr. 29, 1921, pp. 520–522, 7 figs., *d*)

PRODUCER GAS

Water-Gas Apparatus and the Use of Central District Coal as Generator Fuel, Wm. W. Odell. Many gas companies are facing considerable financial difficulties as a result of the greatly increased cost of gas oil used to enrich water gas. Reconstruction of plants to manufacture coal gas instead of water gas is difficult, if not economically impossible, under present conditions. One of the economies by which an attempt is being made to meet the situation is the use of cheaper grades of coal to replace anthracite or coke, and the present paper presents certain preliminary studies bearing on the possibility of substituting Indiana and Illinois coal for coke in water-gas generator sets.

Prof. T. S. C. Lowe, of Norristown, Pa., appears to have established the basic principle of water-gas generation some 45 years ago.

Many attempts have been made to use bituminous coal as generator fuel with varying success, and the paper mentions eleven objections which have so far prevented the general use of coal in place of coke fuel. Several designs made to meet these objections are discussed, such as the Loomis, the Fahnehjelm, Rew, K & A, and Smith.

The distribution of heat in a water-gas set is discussed in detail and various heat balances presented. An interesting part of the paper is a list of the main requisites for the efficient production of good water gas in quantities from coke fuel and a discussion of coke and coal as generator fuel. From this latter it appears that successful utilization of central-district coal as a generator fuel seems to require the maintenance of the following conditions:

1 Higher temperatures in the fuel bed
2 Larger body of completely heated fuel
3 Increased production of blue gas per given amount of blast or an increased amount of blast with an auxiliary utilization of the excess combustible blast gas
4 A means of carbonizing the coal in the generator without the

formation of a mat or cake in the upper part of the fuel bed
5 The utilization of an increased air-blast pressure to offset the increased resistance of the coking fuel to the passage of air, or the equivalent by a change in design of the set
6 A means of control of clinker, particularly edgings
7 A means of properly distributing the fuel in the generator.
8 A means of thoroughly atomizing the oil
9 A generator so proportioned that the steam used during the run has ample time of contact with the incandescent fuel for the completion of the blue-gas reaction.

The principles of design of a generator set suited for central-district coal is discussed. It is stated, however, that although clinker difficulties may be partly eliminated by the method suggested, it is doubtful if they can be entirely eliminated in that manner. (Paper prepared under a coöperative agreement with the Illinois State Geological Survey and the Engineering Experiment Station of the University of Illinois through its Department of Mining Engineering, published as *Technical Paper No. 246, U. S. Bureau of Mines*, Washington, D. C., 1921, *gp*)

PUMPS

Air-Lift Pumping Plant with Remote Control

A MODERN AIR-LIFT PUMPING PLANT, John Oliphant. Description of an air-lift pumping plant installed by the Philadelphia & Reading Co. at Telford, Pa. In this case the problem was to deliver the water from an artesian well into an elevated tank located at a distance from the well and to control the operation as to starting and stopping from another distant point, and at the same time to control the cooling water supplied to the water-jacketed air cylinder of the compressor, the pumping being at the rate of approximately 100 gal. per min.

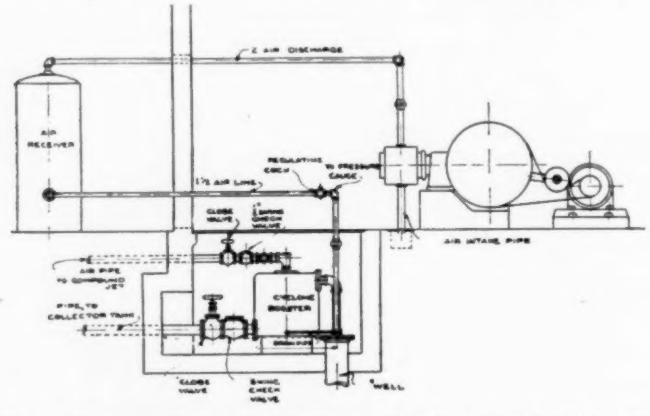


FIG. 7 THE COMPRESSOR, AIR RECEIVER AND WELL IN THE AIR-LIFT PUMPING PLANT OF THE PHILADELPHIA & READING CO., AT TELFORD, PA.

The well was equipped with a 3 in. air-lift footpiece having outside air connections and a multiple-orifice mixing tube located centrally in the mixing chamber and discharging the air through a number of small openings into a relatively thin sheet of ascending water. It is claimed that this design secures a complete emulsion of air and water in the footpiece.

In the pit around the well head and connected to the reduction pipe was located a Sullivan cyclone booster 30 in. in diameter by 30 in. high. The combined air and water was discharged into this booster and separator near the top and at one side at a tangent to the periphery under high velocity from the well, causing it to swirl and thus effect a perfect separation of the air and water. The water leaves the separator at the bottom, also at a tangent to the periphery, and the air passes off at the top. The air pressure in the booster is controlled by a valve set to maintain the pressure required by the head against which the booster is discharging, this head being caused by friction in the pipe (536 ft. of horizontal run, a rise of 14 ft. from the booster to the base of the elevated tank, and the elevation of 66 ft.). The arrangement of the compressor, air receiver and well is shown in Fig. 7. In addition to this the original article contains an interesting drawing showing the pipe layout for the air lift.

The regulation as installed is of considerable interest. As it was required to control the plant from a distant point, it became necessary to unload the compressor when it stopped, and in starting to permit the compressor to get up to speed before the load was thrown on. This was accomplished by means of a flyball governor on the compressor that acted as an unloader when it was at rest, and did not admit air to the compressor until the speed had elevated or extended the controlling balls. It was also necessary to shut off the cooling water to the air cylinder when the compressor was stopped, and turn it on again when started. This was accomplished by placing a balanced solenoid valve of the normally closed type in the cooling-water line controlled from the starting control at the switchboard.

A push button, together with a relay, were located at the pumping station. In the railway station, 3600 ft. from the plant, another push button was installed and an electric-connected pressure gage at the base of the elevated tank was connected to a bell at this latter point to give the alarm when the tank was full of water. Provision was then made for starting and stopping the plant either at the pumping station or at the station 3600 ft. away. As the compressor is of the enclosed, splash-lubrication type, and is equipped with a McCord force-feed lubricator, it is safely manipulated from the station, where a push of the button by the station agent starts the pumping and when notified by the ringing of the bell that the tank is full, another push stops it. The air and water lines were laid so as to drain back into the booster, and a small connection with a partly opened valve was made from the bottom of the booster back into the well, so that all connections drain to obviate freezing in cold weather during idle periods.

A record is given of a test run, from which it would appear that with a total head of 149 ft. the theoretical horsepower required was 3.55 hp. while the actual electrical input was 12.5 hp., which would indicate an overall efficiency (wire to water) of 28.5 per cent. (*Railway Maintenance Engineer*, vol. 17, no. 5, May 1921, pp. 172–174, 3 figs., *d*)

Rotary Pump of Novel Design

EXETER ROTARY PUMP. The Exeter rotary pump built under the Feuerheerd patents is an application to pumps of the principle of the square-hole drilling device, in which a triangular bit functions inside a restraining square former of equal size. The irregular spaces increasing and diminishing in volume as the two rotate together are utilized to admit and eject the fluid.

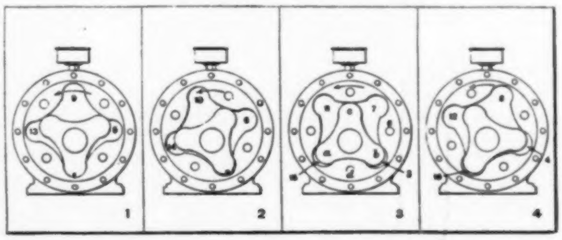


FIG. 8 CYCLE OF MOVEMENT OF THE ROTORS OF THE EXETER PUMP

Fig. 8 shows the cycle of movement of the rotors of the Exeter pump. One of the interesting features is that the pump is self-priming. It has, of course, no valves. As there are no surfaces rubbing against each other, this pump may be used to handle dirty and gritty water. The capacity of the pump per revolution is equal to three times the volume of space 9 in volume 1 of the illustration. (*The Nautical Gazette*, vol. 101, no. 19, May 7, 1921, pp. 597 and 609, 1 fig., *d*)

SHIPBUILDING (See Internal-Combustion Engines)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Strains in Crankshafts Due to Vibration

The Special Committee of the Research Committee on the Strains in Crankshafts due to Vibration is about to begin its actual work. The tentative plan of investigation is given below. The membership of the Special Committee is as follows:

N. W. Akimoff, *Chairman*	Comdr. Wm. McIntee
B. A. Behrend	F. Hymans
Prof. A. H. Beyer	Lt-Comdr. M. W. Torbet
John E. Burkhardt	C. P. Wetherbee
H. C. Dickinson	Dr. E. C. Newcomb
Comdr. F. C. Cleary	Prof. Wm. H. Kavanaugh

General Object and Scope of Work

I Descriptive Part:
  Shaft failures:—Description of circumstances and conditions
  Vibrations:—Description of circumstances and conditions
II Design:
  Usual principles of, in marine, land and automobile practice
  Illustrations
  Counterweights
  General remarks on lubricating systems
III Elements of theory of elasticity required for this investigation
IV Dynamics of the reciprocating mechanism in its relation to subject at hand
V Elements of the theory of vibrations with special reference to torsional vibrations
VI Theory of damping devices
VII Methods of measuring amplitudes of vibrations and strains in crankshafts
VIII Outline of an analytical method of finding torsional "periods"
IX Synopsis of conclusions.

Research Resume of the Month

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches, which in the opinion of the investigators do not warrant a paper.

Automotive Vehicles and Equipment A6-21. Steering Knuckles. Report No. 265 of the Experimental Department of the Packard Motor Car Company gives a formula for the design of a steering spindle and steering arm for racing cars. The spindle is designed by the formula

$$D = \sqrt[3]{w\,d/12{,}150}$$

in which D = diameter of spindle at big end in inches, w = total weight on front wheels in pounds, and d = diameter of front tire in inches.

The material shall conform to specifications 6135 or 3435 of the S. A.E. and shall be heat-treated to give the following:

Elastic limit	110,000 lb. per sq. in.
Tensile strength	125,000 lb. per sq. in.
Elongation in 2 in.	17 per cent
Reduction in area	55 per cent
Brinell hardness	255–386

A steering arm shall be designed by the following formulas:

$$Z_b = \frac{w\ a}{18{,}000\ b}$$

$$D_b = \frac{\sqrt[3]{w\ a}}{1765\ b}$$

$$u = \sqrt[3]{\frac{w\ a}{3000\ b\ k^2}}$$

in which Z_b = minimum section modulus at point of lever arm a
w = total weight on front wheel in pounds
a = distance from center plane of wheel to spindle pin axis in inches
d = distance from spindle-pin axis from center of gravity to steering arm section in inches
D_b = diameter at section of arm
u = width of rectangular section with thickness v in which $k = u/v$

The width u shall be the dimension measured in the horizontal plane. The maximum value of k shall not exceed 2. Material used for the steering arm is the same of that of the steering spindle, but the heat treatment gives elastic limit at 100,000 lb. per sq. in., tensile strength 120,000, elongation in 2 in. 18 per cent, reduction of area 55 per cent and Brinell hardness 228 to 269. Packard Motor Car Company, Detroit, Mich. Address L. M. Woolson, Experimental Engineer.

Chemistry A1-21. Soda Glass. A soda glass of 30 per cent sodium oxide is produced as a by-product of one of the processes of refining nickel. This may be used as a black glass suitable for counters or table glass, and by leaching this glass a soluble alkali can be recovered with a residue which has the same properties as the water softener permutit Address John F. Thompson, Manager Technical Department, International Nickel Company, 43 Exchange Place, New York.

Hydraulics A1-21. Centrifugal Pumps. The measurement of hydraulic losses due to centrifugal pumps has been studied at the University of Michigan. Six propellers have been used and the effects of various dimensions have been carefully studied. The effect of air leakage in the suction line has been studied as well as the effect of this on capacity. Address Prof. J. E. Emswiler, University of Michigan, Ann Arbor, Mich.

Hydraulics A2-21. Reservoir Pipe Connection. An investigation has shown that the velocity head in the pipe line at the entrance to a reservoir is not entirely lost. Address Prof. J. E. Emswiler, University of Michigan, Ann Arbor, Mich.

Internal-Combustion Engines A2-21. Flame Propagation in Automobile Engines. For a graduating thesis at Rose Polytechnic Institute, R. J. Owen and M. G. Flesher determined the rate of flame propagation in an automobile engine in the following manner: One spark plug was removed and a special casting made which permitted the attachment of an ordinary indicator suited for gas-engine testing, together with a spark plug having extended plug removed. An electric motor through suitable reduction gearing drove at constant speed a drum which communicated motion to a continuously moving strip of paper. The strip of paper was carried across the drum of the indicator so that a continuous card was traced. At the same time a standard tuning fork of 250 vibrations per second traced a sinuous line which formed the measure of time intervals. The experiments were made on an Atlas-Knight engine fitted with a Stromberg carburetor. The auxiliary air was closed off and a pipe extension fitted to the main air intake. A pitot tube in this pipe extension served to measure the air used. The gasoline used in a definite time was also determined, so that from a combination of the two readings the ratio of air to gasoline could be found. Tests were made with different makes of gasoline and different proportions of air to gasoline. As was anticipated, the rate of flame propagation is much more rapid for these mixtures than for mixtures of gas and air as determined by previous experimenters. The time interval between ignition and the attainment of maximum pressure varied from 0.004 sec. to 0.014 sec. Each grade of gasoline showed a maximum rate of combustion for a definite ratio of air to gasoline, either side of which ratio the combustion was slower. Various trade gasolines gave the most rapid combustion at ratios of 12 to 1 or 13 to 1. A mixture of gasoline and benzol containing about 40 per cent of benzol showed most rapid combustion with a mixture of 16 to 1. Address Prof. F. C. Wagner, Rose Polytechnic Institute, Terre Haute, Ind.

Metallurgy and Metallography A10-21. Losses in Aluminum and Aluminum Alloy Melting. Report No. 2239 of the Bureau of Mines by Robert J. Anderson discusses the losses in melting non-ferrous metals. The factors to be considered are:

1 The type of furnace
2 The melting temperature
3 The length of time for melting and superheating to pouring temperature
4 The length of time during which metal remains in the furnace at pouring temperature
5 The constitution of furnace atmosphere in contact with the metal
6 The volume of air and products of combustion passing over the metal per unit of time.

The fuel consumption depends on furnace design, air supply fuel used relation of fuel to air, design of burner, and method of removnig waste gases. The domestic output of aluminum was 225,000,000 lb. per year for the year 1918 as primary metal. The amount of aluminum produced in the form of alloy amounts to 30,000,000 lb. The average recovery from remelting borings and scrap amounts to 65 or 70 per cent and the borings amount to 15 per cent of the casting. The average recovery from furnace dross containing 30 to 60 per cent metallics is not over 80 per cent. All aluminum is melted at least twice and much of it at least several times. The principal loss is due to oxidization, the average loss being about 2 per cent. The great fuel loss in melting aluminum is due to the fact that the furnaces used for this purpose utilize probably from two to eight per cent of the heat of the fuel. The probable loss in melting aluminum amounts to about $3,000,000 per year. Address Director, Bureau of Mines, Washington, D. C.

Metallurgy and Metallography A11-21. Volatilization Process. The Research Department of the School of Mines and Engineering of the University of Utah is publishing in connection with the U. S. Bureau of Mines a bulletin on the volatilization process of abstracting metals from their ores. Patents have been issued as a result of this research which have been assigned to the University for the use of the public. The Bulletin will appear in about six months. School of Mines and Engineering, University of Utah, Salt Lake City, Utah.

Properties of Engineering Materials A4-21. Mill Scale in Pipes. The National Tube Company has found that mill scale on the inside of pipes accelerates pitting and they have devised a mechanical means for its removal. This is an improvement in one of the operations of galvanizing and gives a better appearance to the pipe. Address F. N. Speller, Metallurgical Engineer, National Tube Company, Pittsburgh, Pa.

Pumps A1-21. Centrifugal Pumps. An improved form of centrifugal pump which gives equal efficiencies at varying heads. Address Prof. J. E. Emswiler, University of Michigan, Ann Arbor, Mich.

Welding A2-21. Oxy-Acetylene Welding and Cutting Blowpipes. R. S. Johnston of the Bureau of Standards has recently made a report which is printed in Mechanical Engineering for May 1921. The results of the investigation show that blowpipes in which oxygen is delivered at pressure in excess of the acetylene are subject to flashbacks. All blowpipes are subject to flashback phenomena on account of inherent defects in design. Conditions producing flashback are those existing within the blowpipe tip and head which choke off the flow of one of the gases. This back pressure is due to the confining or restricting the volume flow at the tip end. A blowpipe that cannot maintain under all operating conditions a neutral flame cannot be expected to produce sound welds. All blowpipes tested were incapable of maintaining a neutral flame under all conditions. The average operator checks the acetylene gas flow too much and actually develops an oxidizing rather than a neutral flame. A more satisfactory instrument than the blowpipes investigated will be necessary before the possible limiting strength, ductility or efficiency of welds may be determined. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

B—Research in Progress

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Air B4-21. Air Through Orifices. Experiments to show the coefficients used in determining the flow of air through orifices. Mason Laboratory, Sheffield Scientific School, Yale University, New Haven, Conn. Address Prof. E. H. Lockwood.

Aircraft B1-21. Air Propellers. Prof. W. F. Durand and E. P. Lesley are making a general survey of the tests made on 86 model air propellers tested during the past three years and reported on in progressive parts. The present investigation has for its purpose the general comparison and analysis of all results, reduction to non-dimensional coefficients and representation in tabular and graphical form with nomographic charts for purposes of design. Address Prof. W. F. Durand, Leland Stanford Junior University, Stanford University, Cal.

Apparatus and Instruments B5-21. Observation of Explosion within Gas-Engine Cylinder. See *Internal-Combustion Engines B5-21.*

Automotive Vehicles and Equipment B2-21. Tire Friction. Rolling friction of automobile tires. Mason Laboratory, Sheffield Scientific School, Yale University, New Haven, Conn. Address Prof. E. H. Lockwood.

Automotive Vehicles and Equipment B3-21. Dynamometer Tests. Dynamometer tests of automobile power plants. Mason Laboratory, Sheffield Scientific School, Yale University. Address Prof. E. H. Lockwood.

Automotive Vehicles and Equipment B4-21. Radiators. Tests of automobile radiators, including description of types with their construction and the heat transmission. Mason Laboratory, Sheffield Scientific School, Yale University. Address Prof. E. H. Lockwood.

Automotive Vehicles and Equipment B5-21. Farm Tractors. A bulletin is being prepared by the Engineering Experiment Station of Purdue University on the tests of six farm tractors and one army caterpillar. These tests are made independently of soil conditions. Address Dean A. A. Potter, Purdue University, Lafayette, Ind.

Chemistry B1-21. Nickel Compounds. An investigation of the properties of nickel compounds for commercial uses such as for paint and printing pigments, body colors for ceramic wear and soluble nickel compounds for fungacides. The study so far made indicates that black nickel sulphide, black nickel hydrate, and black nickel chromate would be valuable as pigments for paint and printing, while nickel oxide with zinc oxide seems to offer promise in the production of body colors in ceramic ware. Address John F. Thompson, Manager, Technical Dept., International Nickel Co., 43 Exchange Place, New York.

Fire Prevention B1-21. Fire Possibility of Locomotive Cinders. An investigation covering three years of work to determine actual fire hazard of locomotive cinders. Cinders of different sizes heated to known temperatures of 2000 deg. fahr. were dropped on various kinds of roofing with artificial wind velocities varying from 5 to 30 miles per hour. Cinders used so far have come from anthracite and bituminous coals. North Dakota lignites are now being examined. Address Prof. G. A. Young, Purdue University, Lafayette, Ind.

Fuel Utilization B1-21. Oil Torches and Furnaces. The design and performance of oil torches and oil heating furnaces operated on a vacuum system in place of the ordinary pressure system. University of Minnesota, Minneapolis, Minn. Address Prof. J. J. Flather.

Heat B15-21. Heating Boilers. Tests on two low-pressure heating boilers with various kinds of fuel have recently been made at the Mason Laboratory, Sheffield Scientific School, Yale University. Address Prof. E. H. Lockwood.

Heat B16-21. Steam Radiators. A study of heat transfer through radiators. University of Minnesota, Minneapolis, Minn. Address Prof. J. J. Flather.

Heat B17-21. Heat Transmission. A study of the physical properties of hydrocarbons which bear upon the problem of heat transmission is being made by W. R. Eckart. The study will include a review of all published data available. An attempt will be made to make this of practical use. Address Prof. W. F. Durand, Leland Stanford Junior University, Stanford University, Cal.

Heat B18-21. Heat Transmission. An experimental investigation of heat-exchange apparatus with fluids of different physical properties and under varying rates of flow is being continued by W. R. Eckart. Experimental work previously reported has been continued and in addition an extended series of tests with varying mixtures of steam and gasoline vapor on one side and water and oil on the other side are being made. The pressure and rates of flow are varied. Address Prof. W. F. Durand, Leland Stanford Junior University, Stanford University, Cal.

Internal-Combustion Engines B3-21. Hot Spot. An investigation by Prof. O. C. Berry and C. S. Kegerreis to determine the rate of vaporization of various fuels including kerosene at various temperatures and atmospheric pressure. Address Dean A. A. Potter, Purdue University, Lafayette, Ind.

Internal-Combustion Engines B4-21. Factors Affecting Exhaust Temperatures. In order to properly utilize the hot spot it is necessary to know limits of temperature range in the exhaust gases from internal-combustion engines. Prof. O. C. Berry and C. S. Kegerreis have investigated this problem in connection with the effect of cooling-water temperature, inlet air, ignition timing, gasoline-air ratio, speed and load. A bulletin is being prepared on this matter. Address Dean A. A. Potter, Purdue University, Lafayette, Ind.

Internal-Combustion Engines B5-21. Observation of Explosion within Gas-Engine Cylinder. The Bureau of Standards has developed a glass window attached to the spark plug and observed by means of a stroboscopic disk so as to observe the ignition flame during different times of the stroke. The device will probably be of value in permitting observations on the duration of luminous flame during the power stroke. The characteristic differences of color and brightness at different phases of combustion and their averages with changes in ignition timing, mixture ratio, compression pressure and other quantities. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Lubricants B2-21. Lubricating Oils. A set of tests on various lubricating oils in connection with gasoline motors to determine the best oil under operating conditions. These oils are also being examined for their physical and chemical characteristics. New tests are being devised to determine the value of an oil without making a breakdown test on an engine. University of Minnesota, Minneapolis, Minn. Address Prof. J. J. Flather.

Lubricants B3-21. A conference was held in Philadelphia at the Philadelphia Electric Company and attended by a large number of representatives from various industrial concerns and the Bureau of Standards to discuss the possibility of preparing uniform specimens for steam-turbine oils. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Machine Design B2-21. Friction in Ball Bearings. Tests on the friction in ball bearings are contemplated at the Mason Laboratory, Sheffield Scientific School, Yale University. Address Prof. E. H. Lockwood.

Machine Design B3-21. Fatigue and Machinability of Metals. A research on the fatigue and machinability of metals is being planned at the Mason Laboratory, Sheffield Scientific School, Yale University. Address Prof. E. H. Lockwood.

Metallurgy and Metallography B8-21. Mechanical Treatment of Steel. Elaborate study of the effects of the mechanical treatment on the properties of steel through rolling is being made at the Bureau of Standards. After rolling the steel the specimens are prepared for various mechanical tests including metallographic examination. An endeavor will be made to measure the effects of the various factors which enter into the mechanical treatment of metals. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Petroleum Asphalt and Wood Products B1-21. Prevention of Evaporation Losses in Lease Tanks. Report No. 2236 of the Bureau of Mines by J. H. Wiggins gives the results of tests performed in Oklahoma. The tests showed that by making the tanks gastight losses can be prevented which will soon pay for the cost of capping the tanks. The present method of handling oil shows that about $3^1/_2$ per cent of production is lost on the lease, of which a larger part could be saved by gastight tanks. Bureau of Mines, Washington, D. C. Address Director.

Properties of Engineering Materials B1-21. Monel Metal. An investigation on the mechanical properties of monel metal, dealing especially

with repeated stresses, alternating stresses, torsional stresses, and impact. Recent tests with the Izod machine indicate that monel metal has a higher degree of toughness than any known metal or alloy. Address John F. Thompson, Manager, Technical Dept., International Nickel Company, 43 Exchange Place, New York.

Refrigeration B1-21. Refrigerating Constants. The Bureau of Standards is continuing its program of determining the constants used in refrigeration. So far the Bureau has determined the specific heat of brine, the specific heat and latent heat of ice, the properties of saturated ammonia, and heat transmission through certain insulating materials. Work is now being done on the properties of superheated ammonia and after this the properties of other refrigerants will be undertaken. These will include carbon dioxide, ethyl and methyl chlorides, and possibly sulphur dioxide. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Road Material and Equipment B1-21. Bituminous Pavements. A bulletin is being prepared for the Engineering Experiment Station of the A. and M. College of Texas by Prof. Roy M. Green on the bituminous pavements in Texas, with exception of the bithulithic. Professor Green is now connected with the Western Laboratories at Lincoln, Neb.

C—Research Problems

The purpose of this section of Engineering Research is to bring together persons who desire coöperation in research work or to bring together those who have problems and no equipment with those who are equipped to carry on research. It is hoped that those desiring coöperation or aid will state problems for publication in this section.

D—Research Equipment

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories so that persons desiring special investigations may know where such work may be done.

Julian Simsohn and Associates D1-21. The laboratory of Julian S. Simsohn, Chemical Engineers, of Philadelphia, Pa. is equipped for research in water purification, fuels, and combustion in connection with power-plant operation. The work of this corporation is covered by yearly contracts with weekly inspection and tests of plant operation. The service was established in 1912. Address Julian S. Simsohn, Chemical Engineers, Philadelphia, Pa.

E—Research Personnel

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

Cornell University E1-21. Research Activities. The Department of Experimental Engineering of Sibley College, Cornell University, has been active during the past year along several lines. Investigations made are not reported by printed bulletins and therefore printed matter is not available. The work completed includes the following:

1 Investigation of various makes of hand tire pumps for efficiency and capacity

2 Tests on a new vertical Una-Flow engine

3 Study of the effect of oversize tapping of nuts on the strength and character of the failure of bolts

4 Effect upon the strength of railroad rails of various ways of anchoring

5 Comparative tests of cast iron and of steel radiators

6 Investigation on the mechanical efficiency of a Ford engine

7 Investigation of the forces required to drive staples through paper

8 Study of the proper heat treatment for cotton bailing wire and clips.

The Leather Belting Exchange has moved its belt-testing laboratory from Pittsburgh to Cornell University and a number of experiments are now being made on belts. In addition to this the other work in progress is as follows:

Standardizing the instrument called "Microcharacter," devised for measuring the comparative hardness of crystals in bearing metals

Comparative properties of bolts with cut and rolled threads

Application of the Midgley indicator to a Continental engine

Investigations on the efficiencies of a 45-hp. Diesel engine operated on various fuels

Properties of lubricants under high pressures and low speeds

Design of a friction test machine to investigate the effect of centrifugal forces on the friction losses

Investigation on the tractive resistance of soils in connection with the use of the farm tractor

The theory of the flow viscometer

Address Prof. H. Diederichs, Head of Department of Experimental Engineering, Sibley College, Cornell University, Ithaca, N. Y.

WORK OF THE A.S.M.E. BOILER CODE COMMITTEE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval after which it is issued to the inquirer and simultaneously published in Mechanical Engineering.

Below are given the interpretations of the Committee in Cases Nos. 335 and 347 to 350 inclusive, as formulated at the meeting of April 19, 1921, and approved by the Council. In accordance with the Committee's practice, the names of inquirers have been omitted.

Case No. 335

Inquiry: (*a*) Are manhole frames when of the flanged type, considered reinforcing rings and so necessitate their thickness to be at least that of the shell plate, or are they not so considered, so that they can have a thickness less than the shell plate provided their strength meets the requirements of Par. 260?

(*b*) As no method of calculating the strength of flanged manhole frames is given in the Code, would the following method be acceptable? From twice the median line, *ABCDE*, in Fig. 11, subtract twice the rivet-hole diameter and multiply the result by the thickness of the frame and this by the tensile strength.

Reply: (*a*) The thickness of the shell plate referred to in Pars. 259 and 260 is that required by Par. 180 and the thickness and strength of manhole frames and reinforcing rings shall conform to those required for such a shell-plate thickness. When the shell plate is made of greater thickness, such excess thickness shall be given no consideration in the calculations in these paragraphs.

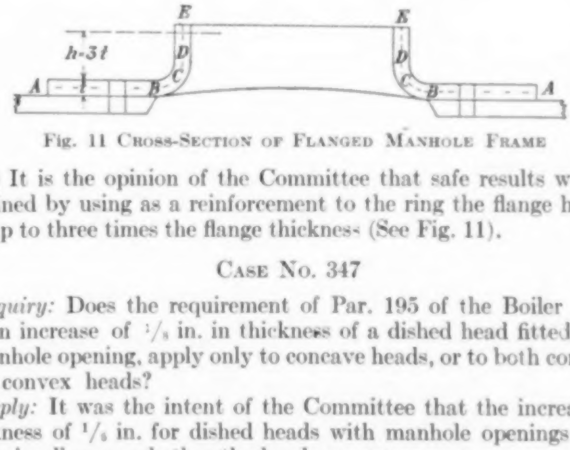


Fig. 11 Cross-Section of Flanged Manhole Frame

(*b*) It is the opinion of the Committee that safe results will be obtained by using as a reinforcement to the ring the flange height (*h*) up to three times the flange thickness (See Fig. 11).

Case No. 347

Inquiry: Does the requirement of Par. 195 of the Boiler Code for an increase of 1/8 in. in thickness of a dished head fitted with a manhole opening, apply only to concave heads, or to both concave and convex heads?

Reply: It was the intent of the Committee that the increase in thickness of 1/8 in. for dished heads with manhole openings shall apply in all cases whether the heads are concave or convex.

Case No. 348

Inquiry: Would the attachment of a forged-steel manhole neck to a convex head, as shown in Fig. 16, be considered the equivalent of a flanged opening supported by an attached flue and thus be exempted from the requirement for the 1/8 in. increase in thickness specified in Par. 195 of the Boiler Code?

Reply: The manhole neck shown in Fig. 16 is not supported in the sense that it assists the convex head in withstanding the stress due to the steam pressure, and accordingly it is the opinion of the

Committee that it cannot be considered that the head there shown is "supported by an attached flue," and therefore it cannot be exempted from the requirement for the $^1/_8$ in. increase in thickness.

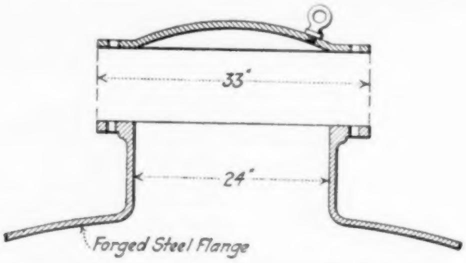


FIG. 16 DISHED HEAD WITH FORGED STEEL MANHOLE NECK

CASE No. 349

Inquiry: Is it permissible, under the requirements of the Boiler Code, in fitting dished heads to the ends of air cylinders or steam drums, to so form the convex head that its flanged edges fit over the outside of the end of the shell, as shown in Fig. 17, instead of within the shell as is usual, in order that a tighter joint may be obtained by calking the edges of the flange to the outer surface of the shell?

Reply: It is the opinion of the Committee that the form of construction proposed is entirely in accord with the requirements of the Boiler Code.

CASE No. 350

Inquiry: Is it permissible, under the rules of the Boiler Code, in fitting different courses of the shell of a boiler at the ends of butt-strapped joints, to weld them together autogenously, in order to avoid the use of plugs or "dutchmen" to render the joints tight?

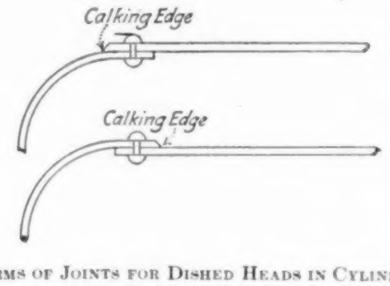


FIG. 17 FORMS OF JOINTS FOR DISHED HEADS IN CYLINDRICAL SHELLS

Reply: It is the opinion of the Committee that if the stress upon the joint is fully carried by the butt straps, the use of welding to render the ends of the joints tight is fully in accord with the requirements of Par. 186 of the Code.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Department of MECHANICAL ENGINEERING are solicited. Contributions particularly welcomed are discussions of papers published in this Journal, brief articles of current interest to mechanical engineers, or suggestions from members of The American Society of Mechanical Engineers as to a better conduct of A.S.M.E. affairs.

Engineering Appraisement

TO THE EDITOR:

Many years have elapsed since the need for the establishment of the value of a property was first recognized. In recent years many conditions have arisen which have necessitated the application of a great deal of engineering skill in properly establishing property values. With the development of the science of appraisement, many technical terms have been introduced for the purpose of explaining the various property conditions which are met with in establishing correct values.

"Property," as the word is commonly understood, may be broadly divided into two classes: one, physical or tangible property; and the other, non-physical or intangible property. Physical property may include such items as land, buildings, machinery, equipment, patterns, drawings, furniture, fixtures, etc. Non-physical or intangible property may include such items as patent rights, trade marks, trade names, good will, business values, etc.

"Value" and "Worth" are nearly synonymous when applied to the inventory of a property. Many conditions, however, are involved in establishing the value of a piece of property. Among these considerations is the use to which this value is to be put, when once determined. In establishing a value of the inventory of a property for insurance purposes, for instance, we have to consider only the present or reproduction value of that property. But if the appraisement is made to establish correct depreciation charges for cost purposes, an altogether different basis of value must be considered.

"Depreciation" signifies a reduction in worth and results, usually, from one or more of several causes. These causes may be, first, wear and tear; second, physical decay; third, inadequacy; fourth, obsolescence.

"Reproduction" Cost, or reproduction value, is the term usually applied to the value which is placed upon an inventory of a property for insurance purposes. In establishing reproduction value, the cost of a machine, as of the date at which the appraisal value is established, must be first obtained. To this must be added an allowance for freight between point of purchase and point of use, and the cost of installation. Reproduction value should never be used as a basis for determining annual depreciation for either cost or tax purposes. "Reproduction value," "cost to replace new," "replacement costs," and "cost of reproduction" are synonymous and are used in reference to an assumed value based on the estimated cost of reproducing the property.

"Cost Value" is the value established at the time used, on the basis of the prices which indicate the actual purchase cost plus freight allowance and cost of installation as shown by the company's books and records. This cost value is subject to a ruling of the Internal Revenue Branch of the Treasury Department which modifies the application of cost values to the extent that where property has been purchased or acquired prior to March 1, 1913, the cost value applied to the appraisement will be the purchase cost as of that date. For all property acquired subsequent to March 1, 1913, actual cost values as shown by the books and records of the company may be used. It is upon this original cost, or purchase value as of March 1, 1913, that depreciation rates are applied in order to determine proper depreciation charges for cost purposes or for tax purposes. Further, it is in the proper establishment of original cost figures and proper depreciation allowances that the careful and scientific appraisement influences the profit showing of the business.

From the standpoint of the engineer, there is probably no other portion of the work involved in making an appraisement which requires more engineering knowledge and skill than that which has to do with the average life of the particular piece of property under consideration. Values may have been properly established, either with respect to cost or with respect to reproduction. Depreciation may have been accurately figured and extensions accurately made. Totals may have been properly summarized and the value of the property carefully shown. All of these elements, however, may grossly misrepresent the going value of a piece of property

if the depreciation study has been improperly made and the average life of a machine has been improperly determined.

No prescribed rule may be laid down to indicate the average lives or depreciation rates of various kinds of property. The Treasury Department recognizes this principle in determining the average life of a piece of equipment under various conditions and kinds of use, in prescribing that the burden of proof as to correct property values and correct depreciation rests with the taxpayer.

After a complete inventory has been made of all of the various classes of property which are to be appraised, and after reproduction costs of these various classes of property have been established, actual cost figures must be applied to the various items as shown on the inventory in order to set up a correct cost value. Idle equipment must be separated from equipment and machinery in use. Depreciation must be applied upon the estimated average life of the particular piece of equipment. Present depreciated costs must be computed by deducting the amount of estimated depreciation from the cost value of the property.

After these various steps have been completed and the appraisal properly summarized to indicate totals of various classes of property by units for insurance purposes and by departments for cost and tax purposes, provision must be made for maintaining a complete record of all purchases of additional machinery and equipment which may take place in the future. For when an appraisal has been properly made and provision has been made for taking care of additions of property, a true record may, with very little trouble, be maintained so that it will show at all times a very close approximation of the cost value of the property as it exists. A proper statement of reproduction values may not be readily established without the assistance of a competent engineer trained in the methods of making such an appraisement.

In establishing the value of a property by means of an appraisal, two broad classes of business may be considered: namely, industrial property and utility property. Utility valuation in recent years has called for a great deal of engineering knowledge and technical skill, and the natural result of the application of this talent in utility appraisement has been to bring it to a high standard of perfection, while up to the time that federal income-tax requirements necessitated a more exact statement of property values, industrial appraisement was not so exacting in its requirements and therefore had not reached the same stage of refinement.

Appraisals may be made for many special purposes, and in the case of the appraisements of utility properties the outright sale of the property or an application for a readjustment of rates for service may be involved. There are five prime purposes for which appraisements of industrial properties may be made: First, for the proper determination of reproduction values for insurance purposes; second, for determining proper annual depreciation charges for cost purposes; third, for determining proper annual depreciation charges for federal tax purposes; fourth, for the determination of invested capital; and fifth, for financial purposes.

In briefly explaining these various uses of a report of appraisement, we will take them up in order as follows:

First, reproduction values of property vary with market conditions. It is therefore necessary to have a property revalued from the reproduction standpoint frequently so that proper and ample insurance protection may be maintained at all times. In the case of a serious fire loss a complete inventory of property is always on hand for adjusting fire losses, and insurance is maintained on an ample basis to cover such losses.

The second use to which a report of appraisement of a property may be put is in determining proper annual depreciation charges for the purpose of making provision for depreciation in charges to production cost. A report of an appraisement should be summarized departmentally, where departmental burden rates are being applied, so that after depreciation charges have been calculated on the basis of original cost or reproduction value as of March 1, 1913, they may be distributed to the various departments within the establishment to which they apply. These departmental values may also be used in connection with the distribution of other fixed charges such as insurance, taxes, etc. It has been the part of good business and the maintenance of a conservative policy in the past to use liberal depreciation rates. The result of this has been to depreciate the purchase cost of equipment in a plant more rapidly than the depreciation has actually taken place. With present conditions, and a heavy tax facing business, in a great many cases it is desirable to revise this past method of applying depreciation, in order to approach more nearly the actual condition. Again, in many cases of old and conservative companies many items of equipment and machinery which may be properly capitalized have been written directly into expense. This procedure naturally eliminates the possibility of applying depreciation to these values and therefore lowers correspondingly the amount of depreciation which may be written into costs and therefore deducted from profits. This condition may be remedied only by means of a proper engineering appraisement.

Third, much the same conditions prevail with regard to ascertaining the proper amount of annual depreciation for federal tax purposes as apply to the requirements of proper cost accounting. Overdepreciation precludes a proper statement of the affairs of a business, and in many cases an overstatement of profits. Charges to expense account of capital items reduce the capital asset account and reduce the amount of depreciation which should have been charged to production cost and therefore deducted from profits. The Internal Revenue Branch of the Treasury Department has placed the burden of proof of a proper statement of fixed assets and proper depreciation charges upon the taxpayer, and each business must therefore show a proper statement of its affairs in order to make a proper return of its income to the Government. Imperfect records of plant accounts preclude the possibility of proper deductions being made from fixed-asset accounts and from depreciation accounts when machines or equipment are sold or otherwise disposed of. Again we have a condition where it is impossible to make a proper statement of fixed-asset values or depreciation amounts without an appraisal.

Fourth, for the determination of invested capital. There are a number of items which may enter into the determination of invested capital. As we have stated, the assets of a business are divided between tangible and intangible assets according to their nature. From the standpoint of tax exemption these are again divided as between admissible and inadmissible assets. In establishing the amount which may be claimed for exemption under the 8 per cent clause of the Treasury ruling, a correct inventory of all plant items must be established. This inventory may also include other items which are usually subject to appraisement, and which may be included as a portion of invested capital. This inventory should be valued at cost prices, and when properly established forms a part of the schedule upon which the amount of invested capital is based. The method of establishing this value differs from that used in the reproduction or usual cost appraisement and requires considerable knowledge of the application of the law.

Fifth, a clear statement of property values in the shape of an engineering appraisement may be very beneficial in cases where additional stock certificates are to be issued, where bonds are to be issued, in the case of mergers or consolidations, in the case of purchase, sale or lease of property, in the extension of bank credit, etc. While it is true that a banker will scrutinize more carefully the current assets and current liabilities than he will the other items on the statement of a business, it is equally true that where he finds a proper statement of fixed assets backed up by detailed statement of appraisal, he will have more confidence in the report of the affair of a business than he might otherwise have. As a basis for making a loan a banker must be able to judge of the potential capacity and productivity of the business. One of the factors to be taken into consideration is the true statement of the valuation of the property. Where many intricate problems present themselves, the skill and technical knowledge of an engineer are required to properly handle these problems.

Chicago, Ill. L. V. Estes.

The *Technical Review*, quoting from *Industritidningen Norden*, states that a Norwegian firm has succeeded in constructing special electric furnaces from which ferrochrome steel free from carbon can be turned out at a cost slightly higher than that of ordinary steel. An English firm has ordered 25,000 tons of the new steel, to be supplied during the next five years.

Lubrication and Hot Bearings

To the Editor:

The editorial by C. H. Norton in the May issue of Mechanical Engineering on the subject of lubrication and hot bearings is very interesting and contains some valuable ideas. However, it appears that Mr. Norton has been unduly influenced by the results of his experiments with a pair of journal boxes and that his final deductions and conclusions may not be safe in their entirety. Nor does it necessarily follow, assuming his data to be correct for a given condition, that they are safe for all conditions of operation.

Mr. Norton has not very completely described the journals and bearings used in his test, and such data as length and diameter of journal, pressure per square inch of projected area thereon when being operated, character and kind of metal used in the bearings—whether babbitt, bronze or brass—are not given. Inasmuch as the behavior of bearings under varying conditions of operation as well as under certain fixed conditions is very largely dependent upon a number of factors other than speed and lubrication, a complete description of bearings under test should accompany the records of results if it is desired that the data resulting from such tests are to be complete.

It is noted that during a test at a speed of 1000 ft. per min. most of the oil was scraped from the journal into the recess. This no doubt shows what may be expected to take place under the conditions obtaining during the test, but so far as the writer can see, there is no similarity between the conditions where a bearing is being continually supplied with oil, as is done in actual everyday practice, and where the oil supplied is managed as was done during the test described.

Regarding the value of oil grooves in bearing shells, it would appear that actual experience has shown that a bearing properly and carefully grooved is safer than one not grooved. So far as the grooves' effecting a reduction in the net bearing surface is concerned, any bearing so limited in wearing surface as not to permit of the cutting of small oil channels will not likely be a safe bearing to use, since any properly proportioned and designed bearing will permit of the use of suitable oil channels and still be liberally on the safe side so far as bearing surface is concerned.

In general, it may be stated that it is better to run any bearing reasonably cool rather than at high temperatures, even though such high temperatures may be considered safe; and, further, even though the internal friction of the oil may be less at the higher temperatures, because of the fact that after a bearing reaches a certain degree of heat only a small additional increase in temperature is required to develop serious trouble, which may result in a damaged bearing and the loss of the machine from service. It may be said also that thin oil for hot bearings is not by any means always the correct oil to use, for it often happens that a medium and sometimes a heavy oil is the only lubricant that can be safely used on bearings to reduce the temperature after they have gotten too warm for comfort.

Atlanta, Ga. C. T. Baker.

Diesel Engines in Kansas

To the Editor:

The fact that the manufacture of Diesel engines has been steadily increasing in the United States may be verified in many ways. One impressive instance that bears out this conclusion is that prominent manufacturers who formerly were engaged in steam-engine construction are now giving more of their time to the production of Diesel engines. One or two cases are reported in which manufacturers have discontinued steam-engine construction and are now devoting their entire attention to the Diesel engine.

In turning to Diesel-engine installations, it would be natural to assume that these were proceeding more or less uniformly, no locality being especially favored. Kansas, however, is a typical locality in which conditions are favorable for their use. Most of the towns in the state are small and well separated, a condition that is favorable to the small central station in each locality. Steam plants find it impractical in most cases to operate condensing because of the scarcity of water, and few of them make any attempt to improve the economy by utilizing exhaust steam for heating purposes. Furthermore, coal prices are comparatively high, and while Kansas is blest with an abundance of fuel oil, its cost for steam generation exceeds that of coal. Kansas could thus be considered a state that would be more than interested in the Diesel engine as a means of better economy in the production of power.

In studying the various installations of full-Diesel engines in Kansas some interesting facts are disclosed. On January 1, 1920, authoritative data show that the total installed rating of the central generating stations in the state was 138,000 kw.; 13.4 per cent of this power was generated by hydroelectric plants, 21.6 per cent was developed by the steam engine, 55.0 per cent by the steam turbine, and 10.0 per cent by gas and oil engines.

Since water power and steam turbines are confined to the large plants in the state, we can reasonably assume that the 21.6 per cent or 41,900 hp. developed by the steam engine and the 10.0 per cent or 19,300 hp. developed by the gas and oil engine are representative of the small central station. If this be true, 32 per cent of the power generated in the state by the small central station is gas or oil power, and 4100 hp. or 21 per cent of this is generated by full-Diesel engines.

To appreciate fully the work that the Diesel engine is doing in Kansas, it is necessary to go beyond central generating service. There are approximately 30,000 hp. of Diesel engines installed in the state for all classes of service. Only 10 per cent of this power is utilized by the small central station, however, the remainder being used in such service as irrigation projects, pipe-line pumping, flour mills, grain elevators and refrigerating plants. The first engine was installed in the state about 1912. Thus, in approximately ten years the total rating in horsepower of Diesel engines has increased so that today it is practically equal to that developed by the state's water power.

Manhattan, Kan. J. P. Calderwood.

Efficiency of Centrifugal Pumps

To the Editor:

The writer was particularly interested in the excellent paper, The Present Trend of Turbine Development, by L. F. Moody appearing in the April issue of Mechanical Engineering. One might, however, take a slight exception, to one of the curves of Fig. 13, namley, Curve *Q*, showing pump efficiencies attained up to the year 1920.

Referring to this curve, the writer would be greatly interested to learn if such high efficiencies as 65 per cent have been obtained with runners of as low a specific speed as 20. If such is the case it certainly is a very remarkable and creditable performance and data on such pumps would prove very interesting as the usual experience with pumps of that low specific speed is rather disappointing and the efficiency is much more likely to be between 40 and 50 per cent than 65 per cent.

A further study of the curve shows that for a specific speed of about 50 an efficiency of 80 per cent might be expected. This, too, is very unusual and much higher than is generally realized for runners of that specific speed; 60 to 70 per cent is more usual and corresponds rather closely to present American practice. It would be of interest to learn whether this curve was plotted from points actually obtained or constructed from theoretical analysis.

It should be stated here that curves as drawn in Fig. 13 applied to centrifugal pumps are a little misleading. The same applies to a lesser degree in regard to water turbines. The reason for this is that the efficiency is not entirely a function of the specific speed alone but is affected to a considerable degree by the capacity for which the pump is designed.

It is possible to design pumps of equal specific speed but of widely different capacities and each will show in general a different efficiency, usually increasing somewhat with the capacity. For this reason a pump having a specific speed of 50 would show an efficiency of 80 per cent only if the capacity were such as would permit it, and in the experience of the writer this is not usually obtained at discharges much less than 3000 gal. per min.

Ann Arbor, Mich. Allen F. Sherzer.

[The foregoing discussion of Mr. Moody's paper was referred to the author, who in reply has submitted the following communication.—Editor.]

To the Editor:

Prof. A. F. Sherzer's discussion of the writer's paper in the May issue on The Present Trend of Turbine Development has been read with interest.

In regard to Professor Sherzer's reference to Curve *Q*, in Fig. 13 of the paper, showing pump efficiencies, it should be explained that this curve was drawn tangent to the Curve *M*, representing pump efficiencies up to the year 1911. The latter curve was intended to be reproduced from Fig. 461 on page 603 of Pumping Machinery, by Prof. A. M. Greene, Jr., edition of 1911. The latter curve terminates at a specific speed of about 30, and the curve shown in Fig. 13 has been extended slightly beyond the original point, and in this extended portion does not represent actual results. I agree with Professor Sherzer's remarks regarding the poor efficiencies usually obtained in this part of the pump field. The highest result of which I have any record at hand in this part of the pump field is an efficiency of about 73 per cent at a specific speed of about 34, shown on the upper part of page 603 of Greene's Pumping Machinery.

The great dependence of pump and turbine efficiencies upon the dimensions of the machine has been alluded to in the article. Thus Curve *H* was stepped up in efficiency from Curve *G*, to allow for the increase in efficiency obtainable in larger turbines as compared to the small models from which the test results were obtained. As comparison of Curves *J* and *K* shows actual results on two turbines geometrically similar, but one of which was about double the size of the other. It is also stated in the article with regard to the generally lower efficiency of pumps as compared to turbines that "much of the difference the writer believes to be attributable to the generally smaller dimensions of pumps," and this point probably counts in some measure for the low efficiencies which Professor Sherzer mentions in connection with pumps of very low specific speeds, since such pumps are seldom built in large sizes.

Professor Camerer has formulated the effect of difference in size, etc., upon turbine performance, in the section beginning on page 299 of his book Vorlesungen über Wasserkraftmachinen (1914), and the same principles would apply to pumps as well as to turbines. The Camerer formula is not strictly correct, for the reason that it assumes all of the loss to be of the nature of pipe or channel friction, thus neglecting the portion of the losses in turbines or pumps due to loss of velocity head in turbulence, eddies, or final discharge. The Camerer method, however, does give us some idea of the effect of change of size upon turbine and pump performance

Philadelphia, Pa. Lewis F. Moody.

Measurement of Energy Used in Impulse Machines

To the Editor:

When considering the problem of arranging a motor for a machine of the impulse type, such as a punch, shear, etc., about the first thing to be determined is how many foot-pounds of energy are used up during each cycle of work. The plants which are fortunate enough to possess the laboratory equipment for determining this are very few in number, and the writer of this article believes that a simple and very accurate method developed and used by him may be of interest to engineers dealing with the problem of motor drives for such machines.

Machines of this class are usually equipped with a flywheel which stores up energy from the motor during the period in which the machine is inoperative, and which gives out this energy to the machine when a clutch is thrown in. Between strokes the flywheel is simply running loose, and if the motive power were shut off, it would gradually be brought to rest by its own friction on its bearings. When stopping in this way its deceleration is constant. The writer has plotted revolutions per minute against time for a number of flywheels coming to rest in this way, and has in each case found a straight-line law. Since the deceleration is constant, we know that the retarding torque is constant, because torque equals moment of inertia multiplied by angular acceleration (or deceleration) and the moment of inertia for any given flywheel is of course always the same. We also know that work equals torque multiplied by angle turned through (in radians), so that if we knew the angular deceleration o' a flywheel, and counted the number of turns which it made in coming to rest from any given speed, we could tell the amount of work originally stored in it by the product of moment of inertia × angular acceleration × angle turned through in stopping. This last would be number of revolutions × 2π. This formula can be more compactly written as $I\,\alpha\,\theta$.

Let us now consider an impulse machine with a flywheel large enough to give the machine sufficient energy to make a stroke. It must be possible to cut off the source of energy from the prime mover at will. This is done most conveniently by a motor with a switch, but other forms can be used. When the flywheel is up to speed, throw out the switch and simultaneously apply a revolution counter to the flywheel shaft. The flywheel wil now stop by its own friction and the number of turns it makes in stopping can be read from the revolution counter.

Now get the flywheel up to speed again and throw in the clutch so that the machine makes a power troke. The switch should be thrown out at the same time as the clutch is thrown in, so that this stroke is made by energy taken from the flywheel. The revolution counter should be applied at the *completion* of the stroke and the number of revolutions made by the wheel in stopping should be noted. Two or three men are of course necessary to perform these operations simultaneously.

If θ_1 be the angle turned through to stop when no stroke is made, the original energy in the wheel is

$$I\,\alpha\,\theta_1 \qquad [1]$$

If θ_2 be the angle turned through to stop after a stroke is made, the energy remaining in the wheel is $I\,\alpha\,\theta_2$ and the energy given to the machine is the difference between the two or

$$I\,\alpha\,(\theta_1 - \theta_2 \qquad [2]$$

We have yet to find α, the angular deceleration. We can get this as we know the original angular velocity of the wheel, which we call ω, from the formula

$$\tfrac{1}{2}\, I\,\omega^2 = \text{original energy in the wheel}$$

which is also given by [1] so that

$$\tfrac{1}{2}\, I\,\omega_2 = I\,\alpha\,\theta_1$$

or

$$\alpha = \frac{\omega_2}{2\theta}$$

Substituting this in [2],

$$\text{Energy given to machine} = \tfrac{1}{2}\, I\,\omega^2\left(1 - \frac{\theta_2}{\theta_1}\right)$$

This can be written in a more convenient form

$$W = \tfrac{1}{2}\, I\,\frac{(\text{r.p.m.})^2\pi^2}{900}\left(1 - \frac{N_2}{N_1}\right)$$

or

$$W = \frac{I\,(\text{r.p.m.})^2}{182}\left(1 - \frac{N_2}{N_1}\right)$$

where

I = moment of inertia of flywheel
= (weight in lb./32.2) × (rad. of gyration in ft.)^2

r.p.m. = rev. per min. of flywheel when running light between strokes

N_1 = number of revolutions to stop from full speed by friction alone

N_2 = number of revolutions to stop after a stroke has been made by energy in flywheel

W = energy in ft-lb. given to machine in one stroke.

The above formula gives the amount of work given to the machine for one stroke. If we know the number of strokes per minute, we can multiply W by this, divide by 33,000 and get the horsepower. If we have a speed-torque chart of the proposed motor and we know the allowable drop in speed during a stroke, it is obviously quite easy to work out the proper combination of motor and flywheel for any given machine. Of course, *any* flywheel which is large enough can be used for getting the work done during one working stroke.

The writer has used the above method in selecting motor drives for a large number of impulse machines, and has found that, with reasonable care, perfectly satisfactory results can be obtained.

C. O. Rhys.

Beverly, Mass.

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of

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The Need for Research

Arthur M. Greene, Jr.

THE word "research" may seem to some to be overworked in these days. When one stops to think of the many thing which have been developed during the last two decades from the results of research, we must realize its importance even more than before. One need only think of the gas-filled lamp, of long-distance telephony, of wireless telegraphy and telephony, of oil cracking, of the air brake, of the modern hydraulic turbine and centrifugal pump to prove what we have said. Many of the new inventions have come as the result of research in pure science where the application was not considered in the research, many have come from investigations to determine the facts for the development of a desired result. In any case the world has benefited; in any case we have extended the frontier of knowledge; in any case we have contributed something to the comfort of man and usually we have conserved nature's energy by more economic applications.

The problems of research which interest the mechanical engineer and which require solution are very numerous, and a few which are receiving the attention of the Research Committee of the A.S.M.E. will be mentioned in this short statement.

Few realize the great loss resulting from the inefficient use of gasoline in an efficient engine. The mechanical engineers of Great Britain have made several valuable reports on the gas engine and its action, and from these our knowledge has been greatly extended. The United States Bureau of Mines has very recently made an investigation of automobile action for the purpose of obtaining data for the proper ventilation of the new vehicular tunnel under the Hudson River at New York. This investigation has shown the inefficiency of the mixing devices used on the engines and points clearly to a great saving by careful and continuous inspection of the exhaust gases from the engine and adjustments of carburetors. The investigation points to the possibility of a development of some other type of mixing device to secure proper proportions of gas and fuel.

The use of steam at high pressure and high superheat in the new or projected power houses calls for a further study of the properties of saturated and superheated steam, as there are differences in these regions which must be harmonized. The research must be faced with absolute integrity and with no bias. Personal, reactional or commercial prejudices must be completely removed and the truth aimed for.

The researches devoted to the elimination of waste from friction are important, as this is present in all moving machinery. Two special committees of the Society are at work on this matter, one endeavoring to study lubricants and the other bearing metals. What are the peculiar properties of oils which reduce friction? What are the properties of metals which make a good bearing metal? Why is the friction loss what it is? The answers to these questions will help us reduce this great source of waste.

Meters for the measurement of flow of fluids have been known for many years, but the peculiar features of installation and maintenance, the limitations of different types, the proper care in operation and the correct theory underlying various types have not been stated clearly and collectively. A special committee of our Society is caring for this matter, and their preliminary report will appear at the Annual Meeting. At the present time they are engaged in studying the problem of pulsating flow.

The rupture of marine shafting subject to driving forces which do not stress it excessively, is due to the fact that the force is a periodic one and vibration is set up. The special committee of research on this subject is taking up another phase of research in collecting all information relating thereto and presenting it to the Society for the benefit of the profession. They will present it in a form which may be of use to the engineer—not only do we need investigation of natural phenomena but the work of research includes the presentation of complete data when this is scattered through technical literature extending over years.

Another phase of research for the mechanical engineer is that undertaken by our Mid-Continent Section, the investigation of the commercial development of industries near the supply of raw materials or near the points of consumption for the purpose of eliminating transportation costs and consequent waste.

The preliminary report of the Committee on the Elimination of Waste in Industry of The Federated American Engineering Societies represents another research of the mechanical engineer. This study has revealed many surprising facts not known before, and even facts which are contrary to accepted beliefs of the past. This mention is made to call attention to this type of research.

What can the profession do to help in this great activity?

First, we should insist on having data for our work. When not known we should investigate and determine the data.

Second, we should be willing to give our data to the profession after we have used it for our development work. Many data are buried where they are doing no work and their publication would not damage our business and would help the profession.

Third, financial support can be given to those who are equipped to work for the profession in securing data as the result of research.

Arthur M. Greene, Jr.

The Waste Report

AS this issue of Mechanical Engineering reaches the reader, the edited manuscript of the report of the American Engineering Council Committee on Elimination of Waste in Industry will be ready for the printer. Advance information indicates that the report will be notable for its contents, for the development of fundamental methods for evaluating waste, for the speed with which it was executed, and for the wonderful spirit of coöperation and sacrifice evidenced by the members of the Committee and the managers of the industries considered in the document. In itself it is an example of what can be done with a purpose, a plan, a schedule, and the highest type of unselfish team play.

The Committee proposed to analyze industrial waste, evaluate it, ascertain the causes and suggest measures for getting rid of it. One fact should be constantly borne in mind, however. The report is but preliminary in character, and this has been emphasized again and again by the Committee. It is the message brought

back by a reconnoitering party sent out to determine the best points for a concerted attack on waste in industry, the national economic problem of great magnitude. As expressed by one member of the Waste Committee, it corresponds to the preliminary assay of the metallurgist, the preliminary survey of the civil engineer or the estimate of the designer, all of which must be completed and digested before the actual engineering work can be started.

To conform to this avowed purpose it was important to obtain concrete information quickly. The work actually began on January 3, 1921, and five months later the findings were submitted to the American Engineering Council. The printed report will give the results obtained from intensive investigations of 75 plants in 5 industries, (Building trades, men's clothing, shoe manufacturing, printing and metal trades) and extensive reports on unemployment, strikes and lockouts, sales and purchasing policies, and health and accidents.

After thorough investigation the Committee, to its great surprise, found that there was no standardized method of analyzing and evaluating waste. The first duty was therefore to determine upon an analysis procedure and to set up standards by which waste might be measured. Arduous work was required, but the resulting method, which will be described in the report, is a monument to the Committee's efforts.

In its endeavor to determine the cause and place the responsibility for waste, the Waste Committee faced a severe problem. Obviously waste is not waste unless its wastefulness is known and appreciated. Responsibility for waste cannot be accepted by any individual or group if the waste itself is not acknowledged. The greatest value of the report, therefore, will be its indication of the whereabouts and extent of waste and its assignment of responsibility for waste elimination. This is a far different thing from assigning responsibility for the waste itself.

We can look forward, therefore, to the appearance of a document which will point out broadly the wastes in industry, evaluate them according to a scheme developed by the Committee, and definitely assign the responsibility for their abatement. The elimination of industrial waste is a fundamental requisite for the advancement of our civilization and the work started so ably by the Committee must be carried on coöperatively by commercial, industrial professional and technical societies and associations.

As the society of the industries, The American Society of Mechanical Engineers will devote its entire 1921 Annual Meeting program to the main topic of the Elimination of Waste in Industry, and each of its Professional Divisions will hold sessions which will treat of some definite technical phase of the problem in a thoroughly constructive way. This will be the first organized attack on the waste problem.

Dr. A. E. Kennelly the First French Exchange Professor

The scheme of regular annual exchange of professors between individual universities in France and the United States in academic fields has been extended into engineering and applied science. After negotiations started by Dr. MacLaurin of Massachusetts Institute of Technology in 1919 and consummated finally through the Institute of International Education, a relationship has been established between the French University Administration and a committee representing seven American institutions which goes into effect in the fall of 1921. The French have selected for their first representative, Professor J. Cavalier, rector of the University of Toulouse, and a well-known authority on metallurgical chemistry. He will divide his time during the ensuing academic year among the seven coöperating institutions, namely, Columbia, Cornell, Harvard, Johns Hopkins, Massachusetts Institute of Technology, Pennsylvania and Yale. Although it would have been impracticable to have included a larger number than seven in the American plan, yet it is hoped that other institutions may also derive benefit from the incoming French professor's visit.

The American representative will be Dr. A. E. Kennelly, professor of electrical engineering at Harvard University and the Massachusetts Institute of Technology. Dr. Kennelly has already left for Europe.

The methods of teaching engineering and applied science vary widely in the two countries and the increase in mutual understanding of each other's ideals and viewpoints will be especially fruitful in broadening the engineering profession of America. It is hoped that the plan will operate favorably and lead to an exchange of advanced students to further increase mutual study and mutual friendship.

Eugene Schneider Awarded John Fritz Medal for 1922

The John Fritz Medal for 1922, awarded to Charles Prosper Eugene Schneider, distinguished French engineer and scientist, for "achievement in metallurgy of iron and steel; for development of ordnance, especially the 75-mm. gun, and for notable patriotic contribution to the winning of the war," was presented to him at a meeting of American and British engineers in Paris on July 8.

M. Schneider heads the great Creusot engineering and steel works and shipbuilding plants of France, which with their subsidiaries have 100,000 employees. The remarkable achievements of France in the steel industry during the war were due largely to the genius and energy of Eugene Schneider and his associates in Le Creusot Steel Works. Within two and one-half years France nearly tripled the number of her blast furnaces and increased the number of her open-hearth furnaces by 60 per cent. During the war she increased her production of rifles 290-fold, of machine guns 70-fold, of 155-mm. shells 225-fold, and of 75-mm. shells beyond reckoning.

M. Schneider not only has led in the technical and commercial development of the great and varied steel and other engineering industries of France, but has also given effective attention to the well-being of his men and their families. His schools for workmen, foremen and engineers are among the best in the world. As early as 1877 his company introduced a pension system, antedating similar action by the French Government. He has done much to raise the standards, broaden the outlook and bind the loyalty of his men.

M. Schneider is a member of a number of French clubs and societies. He has received many honors in his own and of the countries for his achievements, among these being the award or the gold medal of the Mining and Metallurgical Society of America, presented to him in 1919.

Dr. Ernest Fox Nichols New President of M. I. T.

The Massachusetts Institute of Technology has selected Dr. Ernest Fox Nichols to succeed the late Dr. Richard C. MacLaurin as president of that institution. A close personal friend of Dr. MacLaurin, he is a full believer in the theory first enunciated by the latter that an engineering school is not doing its complete duty to itself unless it establishes the closest possible relations with the industry of the country. Under Dr. Nichols' guidance, therefore, M. I. T. will continue its plan of organized service to industry.

Dr. Nichols was born in Leavenworth, Kan., in 1869, and was graduated from the Kansas Agricultural College in 1888. He spent several years at Cornell University as a graduate student in mathematics and physics, receiving the degree of master of science in 1893 and doctor of science in 1897.

From 1892 to 1898 Dr. Nichols occupied the chair of physics and astronomy at Colgate University, during which time he was granted leave of absence of more than two years which he spent in study under Professors Planck and Rubens, at the University of Berlin. He was co-author with the latter of Certain Properties of Heat Waves of Great Wave Length, a research which gave physicists new methods of attack. While making this research he devised a new form of radiometer which he later used in this country in measuring the heat from the stars and planets.

In 1898 Dr. Nichols was appointed professor of physics at Dartmouth College, where he remained for five years. During this time he, with his assistant, Assistant-Professor Hull, discovered the pressure of a beam of light, and made accurate measurements of this force.

After a year as professor of experimental physics at Columbia University, Dr. Nichols went to England to lecture at the Royal Institution in London and the Cavendish Laboratory of Cambridge University. In 1905 he resumed his professorship at Columbia, remaining there until 1909, when he was appointed president of

Dartmouth, a position which he held for seven years. From 1916 to 1920 he was professor in physics at Yale. For the past year he has been director of the physical research at the Nela Park Laboratory of the National Electric Lamp Association, Cleveland.

Dr. Nichols has received honorary degrees from a number of colleges and is the author of many articles on scientific subjects.

Arthur M. Greene to be Dean of Enlarged School of Engineering at Princeton

During Commencement at Princeton University it was announced that the trustees of the University have planned to enlarge its School of Engineering for the purpose of giving courses in mechanical, chemical and mining engineering, in addition to those in civil and electrical engineering which have been offered for some years past. These courses will extend over four years, at the end of which time the bachelor's degree will be given. A fifth year will be required for an engineering degree. The plan of the school is one which will not compete with those of engineering schools giving a four-year course, the intention being to make each of the courses mentioned such that the student will secure sufficient engineering training in four years to become an assistant to an engineer, and so be self-supporting, and in addition receive a thorough grounding in physics, chemistry, mathematics, languages, literature, philosophy, economics and sociology to give him a broad outlook on everyday problems. The endeavor will be to make an engineer rather than a specialist.

The fifth year is to be devoted primarily to engineering subjects, including certain courses in engineering economics and possibly a limited amount of research.

Prof. Arthur M. Greene, Jr., of the Rensselaer Polytechnic Institute, has been called to become the dean of the new school and professor of mechanical engineering; he will take up his duties in the fall of 1922.

Professor Greene was born in Philadelphia. He was graduated from the University of Pennsylvania in 1893, receiving the degrees of M.E. and D.Sc. from that institution in 1894 and 1916, respectively. From 1894 to 1907 he was successively instructor in Drexel Institute, instructor in mechanical engineering at the University of Pennsylvania, and professor of mechanical engineering at the University of Missouri, where in 1906 he was Junior Dean of the School of Engineering. In 1907 he was called to the professorship of mechanical engineering at the Rensselaer Polytechnic Institute, where he planned, equipped and developed the present mechanical engineering laboratory. He also planned and equipped new mechanical laboratories at the Universities of Pennsylvania and Missouri.

Professor Greene has served as manager and vice-president of The American Society of Mechanical Engineers and at present is chairman of the Research Committee of the Society, a member of the Boiler Code Committee and chairman of its Special Committee on Steam Piping. He is one of the Society's representatives on the Engineering Division of the National Research Council and on the Executive Board of The Federated American Engineering Societies. He is a past-president of the Society for the Promotion of Engineering Education and the Society of Engineers of Eastern New York, a fellow of the American Association for the Advancement of Science, and a member of The Franklin Institute. He is the author of a number of important treatises on mechanical engineering subjects.

Bradley Stoughton Resigns Secretaryship of A.I.M.E.

After having discharged the duties of Secretary of the American Institute of Mining and Metallurgical Engineers since 1913, during which period the Institute has greatly grown in numbers and influence, Bradley Stoughton has resigned from this office in order to be at liberty to take up other professional activities.

Mr. Stoughton was graduated from Sheffield Scientific School in 1893, with the degree of Ph.B., and from Massachusetts Institute of Technology in 1896 as S.B. He was instructor in the latter institution the following year, and in 1897 became assistant to Prof. H. M. Howe at Columbia University. He was metallurgist for the Illinois Steel Company at South Chicago, Ill., during 1898–1899; chief of the cost statistical division of the American Steel and Wire Company, Cleveland, in 1900; and manager of the bessemer steel department of Benjamin Atha and Company, Newark, N. J., in 1901. From 1902 until his assumption of office in the A.I.M.E. he was in business as a consulting engineer. He was a member of the general engineering committee of the National Council of Defense in 1918–1919. He was for a time head of the metallurgical division and later vice-chairman of the engineering division of the National Research Council.

Mr. Stoughton is a member of the American Iron and Steel Institute, The Iron and Steel Institute (England), the American Society for Testing Materials, International Association for Testing Materials, and the American Electrochemical Society; a trustee of the American Civic Alliance; and a member of the Executive Committee of the N. Y. Association for Relief of the Blind. He is also a member of the Engineers' and Technology Clubs of New York.

He is the inventor of a converter for making steel castings, and a process for oil melting in cupolas. In 1908 he wrote a treatise on the Metallurgy of Iron and Steel which is a standard work on this subject.

Mr. Stoughton brought to the position of secretary a rare combination of abilities not only as a teacher, a designer, an inventor and a writer, but as a forceful speaker on all occasions, and he had an acquaintanceship with the best minds in the world, which he has greatly extended while secretary.

In accepting the resignation of Mr. Stoughton, the Board of Directors of the Institute issued the following words of appreciation:

> The Board of Directors of the Institute, having accepted with regret the resignation of Mr. Bradley Stoughton as Secretary, would put upon record its appreciation of his long and very efficient service to the Institute and further of his willingness to postpone an actual severance of relations with us until it may be convenient for the Board to elect a successor and even until such successor shall have had an opportunity of becoming acquainted with the details and routine of the office.
>
> The Board recognizes the fact that the duties of the office of Secretary have been greatly increased since Mr. Stoughton's first acceptance of this office eight years ago. Our membership at that time—in 1912—was 3500; today it is about 9900, which fact alone means a greatly increased correspondence. While Mr. Stoughton's predecessors in this office were not frequently called upon to travel, excepting upon the occasion of meetings outside of New York City, under the policy introduced some years ago of visiting the Local Sections or having the Institute adequately represented at the meetings of other scientific bodies, Mr. Stoughton has been called upon to travel, and the Board is pleased to believe that in his bearing and in his speeches he has worthily represented the Institute and has enhanced its appreciation among our many members who, for one reason or another, are not able to visit the headquarters frequently.
>
> The Board of Directors expresses the hope that in a new field of activity Mr. Stoughton may have the great success which his abilities deserve, and would put upon record its appreciation of the self-sacrifice with which he has devoted himself to the interests of our organization at the expense of his own professional preferment or financial advantage.

Franklin Institute Awards

At a meeting of the Franklin Institute held on May 18, 1921, honorary membership was conferred upon Gen. John J. Pershing and Frank J. Sprague, consulting engineers of New York City. Mr. Sprague was also presented the Franklin medal for his achievements in electric traction. He was the pioneer of the modern electric railway, inventing the multiple-unit system of electric train control, the constant-speed electric motors, the system of automatic braking train control, etc. He also inaugurated the high-speed electric elevator.

Another recent award of The Franklin Institute is that of the Edward Longstreth Medal of Merit to Jacob M. Spitzglass, vice-president and consulting engineer for the Republic Flow Meters Company, Chicago, Ill., "in consideration of the novelty of recording electrically the flow of liquids in pipes and the mechanical simplicity and excellence of this measuring apparatus." A description of the meter developed by Mr. Spitzglass was given by him in a paper presented before The American Society of Mechanical Engineers in 1919 and printed in the May 1919 issue of MECHANICAL ENGINEERING, page 429.

William B. Cogswell Dies

William B. Cogswell, founder of the Solvay process and manager and vice-president of the Solvay Process Co., Syracuse, N. Y., died at his home in New York City on June 7, 1921. Mr. Cogswell was born in Oswego, N. Y., on September 22, 1834. He received his early education at Hamilton Academy and at a private school conducted by Professor Root of Syracuse. He completed his education at Rensselaer Polytechnic Institute, from which he was graduated in 1851.

For three years after leaving school Mr. Cogswell served as an apprentice in a machine shop in Lawrence, Mass., and was then for a few years connected with a railroad as superintendent of machinery. In 1859 he became superintendent of the Broadway Foundry, of St. Louis, and in the following year organized the firm of Sweet Brothers & Co., Syracuse, which later became the Whitman & Barnes Manufacturing Co.

During the Civil War he was rated as a mechanical engineer in the Army and later was retained by the Franklin Iron Works to superintend the construction and operation of blast furnaces in Oneida County, N. Y. From 1874 to 1879 he was in the mining business. Three years later he became interested in the manufacture of ammonia soda. He went to Europe to make a study of the soda industry and was commissioned by Solway & Co., Belgium, to locate a plant in the United States in 1891. Through his efforts the Solvay Process Co. became famous.

Mr. Cogswell was a member of over a hundred scientific societies, social organizations and clubs, among which may be mentioned the American Academy of Arts and Sciences, the American Institute of Mining Engineers, the American Society of Civil Engineers, the American Chemical Society, N. Y. State Chamber of Commerce, Sons of the Revolution, and the Colonial Society of America. He belonged to many social clubs in New York City and in Syracuse.

He became a member of the A.S.M.E. in 1880 at the time of its organization and served as one of the managers until 1882.

Death of Charles Maples Jarvis

Charles Maples Jarvis, for some years president of the American Hardware Corporation, New Britain, Conn., and for 22 years before that prominently identified with fabricated steel work, died on May 21, 1921, after an illness of two years. Mr. Jarvis was born on April 16, 1856, at Deposit, Delaware County, N. Y. He was graduated from the Sheffield Scientific School of Yale University in 1877 as a civil engineer. He then entered the employ of the Corrugated Metal Co. East Berlin, Conn., as engineer and draftsman. Later he became chief engineer and president of the company and on its absorption by the American Bridge Co. became a director of the latter as well as a vice-president and member of the executive committee. He retired when the company became a subsidiary of the U. S. Steel Corporation. Mr. Jarvis became a member of The American Society of Mechanical Engineers in 1890 and served as vice-president from 1897 to 1899.

Death of Samuel E. Tinkham

Samuel E. Tinkham, connected since 1874 with the engineering department of the City of Boston, Mass., and with its successor, the Department of Public Works, died on April 21, 1921. Mr. Tinkham was born on March 3, 1852, in Taunton, Mass. He was graduated from the Massachusetts Institute of Technology in 1873 in civil engineering and began work in the engineering department of Boston in 1874. In 1914 and 1915 he was acting division engineer of the bridge and ferry division of the Department of Public Works of Boston, and later became engineer of construction of the division. He was prominently connected with the management of the Boston Society of Civil Engineers for more than forty years and was its secretary from 1880 to 1882, and again continuously from 1887 to date. He also belonged to various fraternal, patriotic and social organizations.

U. S. Industrial Waste Commission Proposed

A bill intended to continue and to amplify the survey of the elimination of waste in industry, made by the committee of the F.A.E.S., has recently been introduced in Congress by Senator Calder. The bill provides for the presidential appointment of a United States Industrial Waste Commission consisting of the Secretary of Commerce as chairman and six others, who shall make a study of waste in the utilization of the available supplies in the United States of timber, power, transportation, oil, coal, and essential minerals, and shall recommend improved methods for their utilization. The Commission is also to recommend measures for elimination of intermittent and seasonal production and of national waste. It is to serve without compensation, adopt its own plan of procedure and submit its report to the President on or before Sept. 1, 1922.

John Crerar Library in New Home

The John Crerar Library, Chicago, first opened to the public in 1897, has recently moved into its new building at the corner of Michigan Avenue and Randolph Street. This library is a free public reference library of scientific and technical literature, endowed and maintained by a bequest of John Crerar, a prominent business man of Chicago who died in 1889. At the time of its first opening it had 15,000 volumes ready for use and 7,000 more in the hands of cataloguers. Its report for 1920 shows a total of over 425,000 volumes and 177,000 pamphlets and over 4000 periodicals currently received. Its property is valued at nearly $6,000,000 and it was used during 1920 by nearly 50,000 people despite the fact that it was closed for four months of the year during removal. It is estimated that the property on which the new building is located will provide for the needs of the Library for 150 years. The dedication took place on May 28 and was attended by representatives of various scientific and technical societies.

U. S. Patent Office Relief

The Lampert bill for Patent Office relief has been reported out favorably in the House and the House Committee on Rules will probably make a special rule for hastening its passage. The federal trade commission section which was incorporated in the Nolan bill and which prevented its passage in the Senate in the last session, has been omitted from the present bill, which otherwise closely parallels the Nolan bill.

The Lampert bill provides for about fifty additional employees in the Patent Office at Washington and for an increase of approximately $500,000 in the Patent Office appropriation. This will greatly relieve the serious condition due to the resignation, on account of inadequate compensation, of over 100 examiners and over 150 of the clerical force in the past sixteen months. On account of this shortage of employees, work in the Patent Office has been greatly delayed so that some 46,000 applications for patents are now pending and work throughout the office is months behind.

Under the Lampert bill there will be increases in the salaries of the examiners, commissioners, and clerks ranging all the way from $150 to $2300, according to the character of the work performed, and there will also be various modifications in procedure made necessary by changing conditions during the last few years.

Registration at Engineering Colleges in U. S.

A census of the registration at engineering colleges throughout the United States was recently made by *Engineering News-Record*. Returns from 81 institutions located in 36 states show a total registration for the college year 1920-1921 of 48,312 students in all engineering courses as against 46,395 for the previous year. There has been, therefore, a gain of 4.1 per cent. The figures reveal that mechanical engineering is the most popular of the engineering courses. This year 12,159 students were registered in mechanical engineering and last year 11,693, a gain of 466. Electrical engineering runs mechanical engineering a close second, the figures for this year and last year being respectively, 12,118 and 11,285, or a gain of 833. Civil engineering comes third with 8592 undergraduates this year and 8469 last year. Chemical engineering, with about 6500 students for the past two years, takes fourth place, while the mining engineering course, in fifth place, shows a considerably smaller registration than any of the others.

News of the Federated American Engineering Societies

A.E.C. Sends Resolution of Thanks to A.S.M.E.

The following resolution to the officers and members of The American Society of Mechanical Engineers has been received from American Engineering Council's Committee on Procedure, acting for the Executive Board of the Council:

WHEREAS, The members and officials of the American Society of Mechanical Engineers manifested great interest and gave unsparingly of their time and effort to the preliminary arrangements and meetings leading to the organization of The Federated American Engineering Societies; and

WHEREAS, The office facilities and clerical force of The American Society of Mechanical Engineers were made available and extensively used by officers of The Federated American Engineering Societies during their organization period; and

WHEREAS, The executive and administrative officers of The American Society of Mechanical Engineers were always most attentive to every request for advice and help; be it

Resolved: That the Executive Board of the American Engineering Council in behalf of The Federated American Engineering Societies hereby express the deep appreciation of the engineering fraternity for the valuable, efficient and effective help which has been rendered by The American Society of Mechanical Engineers.

Elimination of Waste Report Made Public at Executive Board Meeting on June 3

THE fourth meeting of the Executive Board of the American Engineering Council was held at St. Louis on the first anniversary of the Organizing Conference which met in Washington on June 3, 1920. As a result of invitations to the leading engineering organizations in the vicinity of St. Louis, a number of representatives of these bodies were present at the meeting.

The outstanding feature of the meeting was the presentation and consideration of the preliminary summary of the report of the Committee on the Elimination of Waste in Industry. This was fully discussed and the report referred back to the Committee for publication. The Committee on Procedure was authorized to accept the offer of The American Society of Mechanical Engineers to arrange for the publication of the complete report in book form. Announcements as to when and where copies of this report may be obtained will be made later.

Upon the recommendation of the Committee on Membership and Representation the following organizations were admitted to charter membership in the Federation: Iowa Engineering Society, Jamestown Engineering Society, and American Society of Safety Engineers. Under the constitution the opportunity of coming in as charter members expired on July 1, but considerable sentiment has developed in favor of extending the time for this purpose and as a result the Executive Board has decided to bring the matter before the next meeting of the American Engineering Council, to be held in January 1922.

Following a discussion as to the possibilities of coöperation between the Federation and the American Association of Engineers, L. W. Wallace, Dexter S. Kimball, and Calvert Townley were appointed a committee of three from the F.A.E.S. to consider this matter with a committee of three to be appointed by the Board of Directors of the A.A.E. The committee was not given any specific instructions. It is to report its findings to the Executive Board.

Among the recommendations of the Public Affairs Committee which were given the approval of the Executive Board were the following:

That no action should be taken in legislation pertaining to the Federal Power Commission; and

That the American Engineering Standards Committee plan for obtaining coöperation with Government departments be sanctioned.

The Committee on Licensing submitted a report containing its new recommendations on the uniform law. After considerable discussion it was decided to send the report back to the committee with the request that a hearing be held at which all interested may have an opportunity to speak and that following this hearing the report be redrafted so that it may receive further detailed consideration at the next meeting of the Executive Board—to be held sometime in September.

The Board approved support for the present bill in Congress to give increased assistance to the topographic mapping program recommended by the Board of Surveys and Maps, on which L. W. Wallace is serving as representative of American Engineering Council.

The recommendations concerning coöperation with the Personnel Research Federation were carried over for further consideration and the question of representation on the National Conference Board of the Building Industry was referred to the Committee on Procedure with power in the event that this matter should again be brought up. Upon recommendation of the Committee on Procedure, J. P. Healy, of Washington, D. C., was appointed alternate to Rudolph P. Miller on the National Board of Jurisdictional Awards in the Building Industry.

The Committee on Foreign Relations reported that it had participated in the reception and entertainment of delegations of Italian and French engineers visiting in this country. A resolution to British engineers expressing admiration for their effective work during the war, and sympathy for the sacrifices in life, health, and property which their services involved, was approved by the Board and a special committee was appointed to draft a similar resolution to French engineers.

Important Amendment to U. S. Patent Laws Proposed

Legislation to require the compulsory working in this country of patents issued to or controlled by nationals of foreign countries has been brought to the front by the introduction of Senate Bill 1838, which carries the following amendent to that section of the patent statutes which deals with the patenting in this country of inventions previously patented in a foreign country:

Any patent or patents issued to a person or persons not citizens of the United States shall contain a proviso to the effect that if such patent so granted is not worked or put in operation so as to result in actual production of the article in reasonable quantities embodied in such patent in the continental limits of the United States within the period of two years from the date of its issue, the United States reserves the right to license any person or persons for purposes of manufacture in the United States, and to use and sell the subject matter thereof.

The amendment subjects this provision to a further provision empowering the Commissioner of Patents to determine a fair royalty to be paid the foreign owner of the patent by the licensee in consideration of the license.

Under the present patent system, a foreign inventor has the right to manufacture, use and vend his invention in this country for seventeen years. But as each of these rights is a separate entity, inventors can take advantage of the economic conditions prevailing in foreign countries and manufacture their inventions in their own countries at less expense than in United States. Even the expense of transportation and import tariffs do not usually increase the cost to such an extent that it would be more economical to manufacture the invention in this country. It has therefore become almost universal practice for a foreign owner of a United States patent to manufacture the invention in his own country, and then take advantage of his right to its sale in the United States.

Supporters of the amendment state that by granting to a foreign inventor the exclusive right to sell his invention in this country entirely independent of the requirement that it also be manufactured in this country, the United States patent laws foster the development of foreign industries and retard the development of our own. An example cited is that of the dye industry, in which practically all developments are held by German inventors or their assignees. While the United States is one of the large users of dyes, her dye industry has not prospered, by reason of the German-held United States patents, while the dye industry in Germany has grown enormously.

On the other hand, there is strong opposition to the amendment by those who point out that it would have a tendency to force the

working of patents in this country which are owned by foreign capital, defeating Americam manufacturers who are trying to make this country independent of, for instance, the German dye and other industries. For if the foreign-owned American patent were of sufficient value to warrant competition here, its owner would be willing to comply with the provision, rather than allow the manufacturing rights to pass into American hands. But if it were an unimportant patent he would lose little and the United States gain little if the patentee failed to comply with the compulsory working provision.

It is further argued that to enact a compulsory working clause applicable only to foreign owners of American patents might easily pave the way for such a clause applicable to all United States patents, even though owned by American citizens. The objections to such a situation are so apparent as to need no enumeration.

The amendment is undoubtedly an extremely important piece of legislation, affecting both the tariff system and foreign relations, and merits the careful attention of all interested in the protection and development of the United States industries.

This amendment, which is known as the Stanley bill, was inaugurated by the War Department and is intended to apply especially to war materials. The Senate Committee on Patents has recommended its immediate passage without amendment.

Licensing of Engineers in New York State

Frequent inquiries as to the working of the New York State Engineers' License Law, passed May 14, 1920, and amended May 6, 1921, have resulted in the publication of the following brief summary covering the chief provisions of the law.

No engineer unless licensed may legally practice professional engineering or land surveying after May 6, 1923, that is, two years after the date the law was amended.

In a corporation, partnership, or joint stock association engaged in the practice of engineering the engineer in responsible charge of the work must be licensed. Subordinate engineers who report to such an engineer need not necessarily be licensed. It is to be hoped, however, that the prestige of a license will be such that all engineers who are eligible for license will apply for one.

Some exemptions are allowed non-resident engineers practicing in New York State. No license is required for:

1 Offering to practice when having no established place of business in New York State

2 Practicing when having no established place of business, provided such practice does not aggregate more than thirty days in one calendar year and provided such non-resident engineer is legally qualified for such professional service in his own state or country

3 Practicing professional engineering or land surveying, provided application for license is pending, and fee has been paid. Such exemption to continue only for such reasonable time as is required for granting or denying of application.

Further exemptions are made for engineers practicing as pupils or under the direction of a licensed engineer, or practicing on work solely for the United States Government, and further, practicing solely as an employee of the state from the time act becomes effective until the expiration of the then existing term of office of such employee.

The registration fee is \$25 for a license either as a professional engineer or as a land surveyor, or \$35 if the license be for both combined. The yearly renewal fee is one dollar if made prior to December 31, with a penalty of ten cents for each month's delay in paying renewal, accumulating to a maximum of two dollars.

An Opportunity for Hydraulic Research

Offers which have been made recently to the Engineering Foundation, if supported by financial assistance, will make possible an extensive research in hydraulics. One of the largest hydraulic power companies in America has offered to coöperate with the Engineering Foundation by making its valuable facilities available in any way in which they can be properly used, and an eminent hydraulic engineer has also offered his advice in conducting such a research. To take advantage of this opportunity, the Foundation states that it needs a special fund of not less than \$25,000 a year for a number of years. Further information may be obtained from Alfred D. Flinn, secretary of the Foundation, 29 West 39th Street, New York, N. Y.

NEWS OF OTHER SOCIETIES

National Electric Light Association

Convention in Chicago on May 31 to June 3. The broad aspects of public relations, finance, operation and business were discussed by leading executives and engineers and by public-service commissioners. An analysis of the fundamental economics affecting the service rendered by electric light and power companies was made by Martin J. Insull in his presidential address. Mr. Insull saw the industry in a strong position, but in need of large sums of money to take care of the program of expansion demanded by the public.

Henry J. Pierce, of Seattle, Wash., surveyed the progress made in the utilization of water power in the United States since the enactment of the water-power act in June 1920. Up to the present time 223 applications for preliminary permits and licenses for development of an aggregate of over 15,000,000 hp. have been made to the Federal Power Commission. According to Mr. Pierce, the difficulty of utilizing the hydroelectric resources of the country comes from the fact that 70 per cent of the primary power used for manufacturing purposes is east of the Mississippi River, while 70 per cent of the hydroelectric resources of the country is west of the Rocky Mountains. The total amount of primary power developed and used at present east of the Rocky Mountains for all purposes other than by railway locomotives is 37,000,000 hp. and the total available water power in that region is about 15,000,000 hp., so that if all of this water power available were developed there would still be a shortage of 22,000,000 hp. to be supplied by steam. On the other hand, 40,000,000 hp. can be developed hydroelectrically west of the Rocky Mountains, and but 5,000,000 primary horsepower is now used, of which 2,000,000 hp. is developed by steam and 3,000,000 hp. hydroelectrically. Guido Semenza, head of the Italian railway electrification commission, spoke on the development in the utilization of water power and interconnection of electric plants in Italy. The hydraulic power committee, which was organized at the convention in Pasadena last year, reported the results of its studies on the development of efficient draft tubes, the control of tailwater level, the relation between rainfall and stream flow, evaporation, and the operation of hydraulic plants for maximum output. Surveying recent developments in the utilization of water power, the report mentions the 55,000-hp. turbines designed to operate under 305 ft. head for the Queenston-Niagara station of the Hydroelectric Power Commission of Ontario, and the use of 22,500-hp. turbines under 800 ft. head at the Kern River No. 3 station of the Southern California Edison Co.

A tendency to increase turbine speeds and to improve turbine economy by raising steam pressure was indicated in the report of the committee on prime movers. Single-cylinder turbines seem to be still limited to 45,000 kw. A new record as regards boiler sizes was established by the installation at the plant of the Ford Motor Co. of four boilers each rated at 2647 hp. Pressures and superheats are gradually rising, although 300 to 350 lb. per sq. in. and total temperatures of about 650 deg. fahr. seem to be the highest values being used at present. Information regarding the burning of "hogged fuel" by the Northwestern Electric Co. of Portland, Oregon was included. This fuel shows a loss of from 30 to 40 per cent in B.t.u. content after being in storage for a year, and it makes little difference whether the storage is indoor or outdoor. The use of lignite has not received any great impetus as a result of the acute demand for fuel during the war. However, very complete tests of lignite have been carried on both in the Bitterfeld station in Germany and at the Melbourne plant in Australia, so that the properties of this fuel under various operating conditions, as well as the design features to be embodied in stokers and furnaces, have been clearly defined. Continued interest has been manifested in the pulverized-fuel method of burning coal. High ratings are obtained in new plants where boilers have ample combustion space and are designed expressly for burning pulverized fuel. The Lakeside plant in Milwaukee, designed for burning pulverized fuel, has recently been put in operation and will have an ultimate capacity of 200,000 kw. Processes for the recovery of by-products from raw coal have been developed further in England and Germany than in this country. Attention was called to the fact that The American Society of Mechanical Engineers is revising piping stand-

ards for pressures higher than 250 lb. per sq. in., acting as the sponsor body designated by the American Engineering Standards Committee with a view to adopting an American standard for such pressures. Following the presentation of the report of the committee on prime movers a discussion ensued on the best specifications for lubricating oils and the economy of burning pulverized fuel. W. J. Santmyer, Puget Sound Light & Power Co., stated that with pulverized-fuel plants, efficiencies are obtained which are unbelievable, boilers can be forced to remarkable overloads, and equipment is particularly flexible in operation. He referred to one 500-hp. installation where the boilers could be put on the line and made to carry 300 to 400 per cent rating in 40 minutes. Joseph Harrington, Brady Foundry Co., questioned the economy of pulverizing coal containing more than 15 per cent ash or 8 per cent moisture. Modern stokers, he said, can burn anything from lignite to anthracite coal and have horizontal efficiency curves from 150 to 250 per cent rating, can increase from 150 to 250 per cent rating in three to four minutes, and can burn coal containing 40 per cent ash without clinker formation.

Technical sessions were also held on electrical apparatus, overhead systems, underground systems, electric meters and inductive interference. An exhaustive account of the technical, commercial, and financial features of the convention is given in the *Electrical World* for June 4.

Society of Automotive Engineers

Semi-annual meeting at West Baden, Ind., on May 24 to 28. Sessions were held on aeronautics, highway transport, general research, combustion and fuel research.

A paper by L. E. Pierce and G. J. Mead on Aviation Power Plant Development stressed the necessity of better installations of the power plant to eliminate engine failures in the air. These generally result from minor defects in the operation of the gasoline, cooling or lubricating systems, which are independent of the engine itself. Discussing this paper Elmer Sperry urged the study of the Diesel engine as a possible power plant for the aeroplane of the future, particularly in view of the fact that this type of engine burns a fuel whose low volatility reduces the fire hazard. The present status of commercial air transportation was surveyed by V. E. Clark in a paper entitled Air Transportation and the Business Man. Mr. Clark admitted that no air-transportation project has proved to be a financial success; but he recalled that it was not until 50 years after the invention of the locomotive that railroad investments returned profits and the manufacture of the automobile became commercially successful in 20 years. The aeroplane is now only 12 years old. The Need for Federal Control in Commercial Aviation was discussed by S. H. Philbin, who presented the matter from a legal standpoint.

In Transport Engineering Education, C. J. Tilden emphasized the need of providing a proper curriculum in the universities in order that men could be given an education which would fit them for the practical management of motor-transport companies. The Vehicle and the Road was presented by A. T. Goldbeck of the Bureau of Public Roads. Mr. Goldbeck advocated greater coöperation between the highway engineer and the automotive engineer. He thought that it might eventually become necessary to lessen the weight concentrated on each wheel by increasing the number of wheels in large motor trucks used for highway transport.

C. W. Stratford explained the research work on lubrication that has been done under his direction on the Pacific Coast. W. E. Lay described the plan recently inaugurated at the University of Michigan to place the laboratory and personnel facilities of the university at the disposal of commercial organizations to promote advanced research study. A paper on Practice and Theory in Clutch Design, by Herbert Chase, contained particulars concerning American and British practice in clutch design, and compared the advantages and disadvantages of various types of clutches.

Turbulence in Theory and in Practice, by H. L. Horning, embodied a collection of data from the experimental results obtained by Chatelier and Mallard, Wheeler and Mason, Prof. Bertram Hopkinson, Sir Dugald Clerk, Harry Ricardo, and other investigators, as well as from a large number of experiments conducted under Mr. Horning's observation. By developing high turbulence in a mixture it is possible to drive off the surface layers of the combustion chamber and thus force their full contents to contribute to the heat and pressure before the expansion stroke commences. Turbulence tends to accelerate the combustion of the entire mixture and makes it possible to obtain high speeds without advancing the spark excessively. C. A. French submitted a hypothesis on the action of flame and combustion in internal-combustion engines. A paper by Sir Dugald Clerk on Cylinder Actions in Gas and Gasoline Engines outlined the fundamental thermodynamic theory of the present-day automotive engine.

The possibility of developing a high-compression engine for use in automotive vehicles was discussed by F. C. Ziesenheim. The conclusion reached by Mr. Ziesenheim was that this type of engine should receive careful study as one of the possible factors in deferring the fuel shortage. George P. Dorris described a manifold developed for the purpose of trapping and distilling the higher ends of modern engine fuels, thus preventing their entering the combustion chamber in liquid form. The Elements of Automobile Fuel Economy were enumerated by W. S. James of the Bureau of Standards. Thomas Midgley, Jr., informed the members of the recent discovery of a fuel dope that was more effective in eliminating fuel knock than any used previously. Owing to the effectiveness of this substance only a small percentage need be added to the fuel, and Mr. Midgley felt that by its use higher compressions might be developed in Otto-cycle engines and eventually a thermal efficiency might be secured which would be comparable to that of the Diesel engine.

American Iron and Steel Institute

General meeting in New York on May 27. Business conditions and remedies for the prevailing depression were the chief subjects of discussion. A notable incident was an appreciation by Gen. John J. Pershing of the activities of the iron and steel industry during the war. In his presidential address Judge Gary expressed his views of the present business situation and its difficulties. He felt that the country was now headed in the right direction, and progress toward recovery, though slow at present, would increase in due time. A number of short speeches by leaders of the steel industry upon present business conditions followed Judge Gary's address.

The educational work being conducted by the American Steel & Wire Co., of Cleveland was described by Charles R. Sturdevant. Seven courses have been established: an intensive course for salesmen, a special business English course for general office forces, Americanization courses for non-English-speaking employees, vestibule schools for skilled and unskilled workers, a trades course for upgrading craftsmen, a special apprentice course for a limited number of technically trained men, and a course for foremen and supervisors. The Americanization, vestibule and trades courses are elementary; the courses for salesmen and foremen are intermediate; the student apprentice course is advanced; the business English is a special course and the library is used as an accessory. Admittance to any of the courses is voluntary on the part of the employee, who is not thereby required to sign indentures or agreements to remain with the company after completing the course. Results have been very gratifying.

Harlow D. Savage, Combustion Engineering Corporation, New York, presented a digest of the work that has been done in the last three years in the equipping of steam power plants to use powdered coal as fuel. There are now throughout the United States about ten commercial plants of large size burning pulverized coal. Some of these plants have been in operation for nearly three years. Mr. Savage asserted that with a correctly designed and properly operated pulverized-fuel system it is fair to expect an efficiency of 77 per cent, judging from results obtained in tests and in actual operation of plants.

The composition, properties and uses of stainless steel, and the method of manufacturing this alloy, were explained by Elwood Haynes, president, Haynes Stellite Co., Kokomo, Ind. Stainless steel must contain iron, chromium and carbon, and may contain various other elements, such as manganese, molybdenum, tungsten, silicon, etc. Immunity to atmospheric influences is acquired when the chromium content reaches at least 8 per cent, and the

highest immunity when the chromium content is 11 or 12 per cent. The best results in the manufacture of stainless steel are obtained by means of the crucible or electric furnace. Stainless steel may be forged at temperatures varying from 800 to 1200 deg. cent. and be readily rolled into rods and sheets under proper conditions. By proper annealing, a bar containing 15 per cent chromium can be rendered sufficiently soft to be worked in the lathe, though even when annealed it is much harder than ordinary machinery steel. When thin strips are heated and allowed to cool in the air they become almost file-hard.

A summary of the practical and commercial features of molybdenum steels was presented by Arthur H. Hunter, president, Atlas Crucible Steel Co., Dunkirk, N. Y. Molybdenum steels, compared with other alloy steels in the same category from a commercial standpoint and treated to the same tensile strength, show a slightly higher elastic limit, a higher elongation, and a much higher reduction of area.

Taylor Society

Spring meeting at Cleveland on May 19, 20 and 21. An address of welcome was made by Alexander C. Brown, president of the Cleveland Chamber of Commerce, who enumerated the present national problems, such as business depression and unemployment, and said that one of the dangers of the situation is that the Government may attempt to settle too many of these problems. He declared that one of the functions of the Taylor Society is to focus its attention on many of these problems and do what it can to solve them without the necessity of legislation. Technical sessions were held on sales executives, administrative officers, plant managers, personnel administration and industrial relations.

Howard G. Benedict, consulting management engineer, Cleveland, spoke on performance rating and bonuses for salaried employees. He described a plan he had formerly tried for rating men and setting a money value on coöperation. Each salaried employee was periodically rated by a rating committee with respect to attitude on coöperation, reliability, ability, action, leadership, and personality. Definite elements were considered in rating each quality. For example, reliability was considered as made up of honesty, truthfulness, dependability, straightforwardness and sincerity.

Morris L. Cooke, consulting management engineer, Philadelphia, in a paper on Unemployment Scores suggested the adoption of standards to measure "unemployment within employment," that is, insufficient work to keep employees busy all of the working time. The test of efficiency in management, he said, is the percentage by which the amount of time actually occupied in production work falls short of the possible maximum based on a predetermined proper length of working day.

Carl Snyder, statistician, Federal Reserve Bank, New York, discussed the value of an index number of physical production to administrator and manager. He showed with charts that industrial production in the United States has been moving upward at a uniform rate during the last fifty years. Assuming that there will not be a sudden change, it would seem that, since present underproduction is more striking than overproduction was last year, a violent reaction must soon take place. Production data, he believed, can be developed to a point where it will not be hard to make fairly accurate forecasts, the problem of overproduction of a particular commodity being really one of unbalanced general production. By maintaining elaborate statistics concerning production in all industries, the supply and the demand of any particular commodity could be made to correspond. Another advantage of the regulation of production would be the elimination of violent fluctuations in prices.

At the session on industrial relations a symposium was held on joint action of employees and management in establishing standards, tasks, rates and other standard conditions.

American Society of Refrigerating Engineers

Spring meeting in Chicago on May 25 to 27. Exceptions were taken to the refrigeration code in its present form. One dealt with the pressure at which the release devices for different refrigerating media should be set. Assuming the value given for ammonia to be correct, the pressures listed for ethyl chloride, sulphur dioxide and methyl chloride are too high and should be reduced to correspond with the pressure given for ammonia. The same reasoning applies to other tabulations. A propeller for brine agitation and circulation designed in accordance with formulas developed by O. G. Halvorsen, professor in marine engineering at the technical college at Trondhjem, Norway, was described by E. A. Burrows. In Spray Cooling Systems, P. K. Lindsay brought out the great increase in cooling capacity obtained by the use of sprays over a basin or pond without the sprays, indicated the piping arrangement used and the operating pressure, described the nozzles, and summarized the average cooling results from a well-designed spray system with unrestricted air circulation. Prof. E. A. Fessenden outlined the results of a series of tests on welded ammonia containers. Four types were tested: (1) Flange-steel shell, acetylene-welded longitudinal seam, concave heads welded to shell; (2) seamless-pipe shell, convex heads acetylene-welded to shell; (3) seamless-pipe shell, concave heads forge-welded to shell; and (4) flange-steel shell, acetylene-welded longitudinal seam, convex heads acetylene-welded to shell. Professor Fessenden concluded that vessels with forge-welded seams are the least desirable. Welds joining fittings for pipe connections to the vessel are almost as likely to cause failure as the longitudinal and circumferential seams. In acetylene welds the principal defects seem to be the coarse granular structure and porous spots obtained and the occasional poor adhesion of the welding material to the original plate. A new type of nozzle which gives a hollow, cone-shaped spray was described by S. C. Bloom. Multiple-Effect Compression, by H. C. White, contained a report of comparative tests on a single-acting compressor and a compressor equipped with the Voorhees device. Other papers were: Arc Welding Applied to Refrigerating Machines, by A. M. Candy; Refrigeration in the Manufacture of Rubber, by J. H. Vance; Modern Air-Compressor Practice and Testing, by Harry Feldbush; Water Treatment for Raw-Water Ice, by John J. Felsecker; and Eggshell Sterilization for Cold Storage, by Elmer Anderson.

International Railway Fuel Association

Annual convention in Chicago on May 24 to 26. Committee reports were presented on briquets and subnormal fuels, fuel accounting, pulverized fuel, locomotive feedwater heating and coal storage. Progress in burning pulverized coal in locomotives and in stationary railway plants was surveyed by the committee on pulverized fuel. Tests were made on a locomotive by the Lehigh Valley Railroad to determine the practicability of burning pulverized North Dakota lignite containing 15 per cent moisture and Red Lodge sludge (Montana sub-bituminous coal) without resulting in serious honeycomb formation or unusual disintegration of brickwork. The results were successful with the exception of the honeycomb formation which with either coal developed rapidly on the back flue sheet when the locomotive worked hard and seriously hampered operation. In stationary practice two new plants burning pulverized coal were completed and put into operation during the year, namely, the St. Francis plant of the Milwaukee Electric Railway & Light Co. and the Oklahoma City Plant of Morris & Co. Progress in the simplification of the Locomotive Feed Water Heater Co. and the Worthington feedwater heaters was reported by the committee on feedwater heating. That fuel accounting be handled by the auditing department was recommended by the committee on fuel accounting. Every railroad engaged in interstate commerce is guided in its final accounts by certain rules and regulations laid down by the Interstate Commerce Commission. The accounting department of every railroad understands these regulations and knows how to meet the requirements with regard to the allocation of fuel charges to operating expenses. Some of the technical papers were: Present Railway Situation, by Samuel O. Dunn; Fuel Conditions on the French Railways, by M. de Boysson; Preparation and Distribution of Fuel, by P. E. Blast; Fuel Department Organization by L. G. Plant; and Value of Individual Fuel Performance Records, by Robert Collett. A very complete report of the convention is found in *Railway Age* for May 27 and June 3.

Engineering and Industrial Standardization

Standard Methods of Identification of Fluids Conveyed by Pipes in Power Houses and Industrial Plants

SAFETY and economy of time in making changes and additions to piping systems demand that in a given layout these systems should be so marked that the liquids or gases passing through them may be readily identified. Many firms have met this need by adopting color schemes of various kinds. In some cases the standard colors are applied only to the valves, fittings and insulation bands, all the pipes being of the same color. In others the color of the pipe in combination with the colors of the valves, fittings and insulation bands is employed to tell the tale.

Since, as is natural, these independent efforts to solve this problem have resulted in the use of a great variety of colors and in an absence of uniformity or standard practice, the American Engineering Standards Committee has been appealed to. After consideration the Committee asked the National Safety Council, Chicago, and The American Society of Mechanical Engineers to act as joint sponsors and to organize a Sectional Committee for this purpose. The members of this Committee are now being selected.

As a result of some recent and previous correspondence the A.S.M.E. Standards Department has gathered together some specific information concerning four systems in addition to the one recommended by an A.S.M.E. committee in 1911. The principal parts of these systems are printed below. A superficial examination of this table will, however, convince one that even though it is long it does not include all the fluids which are in common use in many laboratories and manufacturing plants. A few of the missing ones are oxygen, hydrogen, acetylene, natural gas, and lubricating liquids. It is also probable that acid-manufacturing plants have other materials which must be conveyed by pipe lines.

It can be readily seen, therefore, that with such a variety of materials to be conveyed, the problem of selecting a standard set of color combinations for easy and sure identification will not be an

VARIOUS COLOR SCHEMES FOR IDENTIFYING PIPES IN POWER HOUSES AND INDUSTRIAL PLANTS

Fluid to be Identified in Pipe	Report of A.S.M.E. Committee 1911	The New York Edison Company	Kodak Park Piping	University of Toronto	Westinghouse, Church, Kerr & Company
	Color of edges of all flanges, fittings and valves	Color of pipe fittings, and insulation bands	Color of band	Color of pipe	Color of pipe
Air	gray	black pipe and fittings		dark blue	light green
Air, Compressed			white and black		
Ammonia Gas			white		
Ammonia, Liquid			white		
Brine Return			white and red		
Brine, Supply			white and yellow		
Drip, Gravity discharges from manifold to receiver, from receiver to header, header to boilers and blowdowns and reducer lines		orange pipe and P. Verm. fittings			
Drip, Holly System					cream, buff bands
Electric Lines and Feeders	black and red stripes alternately on flanges and fittings, body of pipe being black				
Drips, Blow off from water columns and all low-pressure drips, roof leaders, overboard discharges from hot-well pumps		lead pipe and black fittings			
Gas, Illuminating	aluminum		white and blue	dark brown	
Gas, Engine Service	black, red flanges				
Oil, Fuel	black				
Oil, Delivery and Discharge, brass or bronze	yellow	tan pipe and black fittings			
Oil, Cylinder, throughout station from barrel tanks to pumps, to overhead tanks, to cylinders		tan pipe and P. Verm. fittings			
Oil, Return, from all bearings and catchalls to filter tanks		tan pipe and light-green fittings			pink
Refrigerating Systems	white and green stripes alternately on flanges and fittings, body of pipe being black				
Steam, High-Pressure	white		black	dark yellow	cream
Steam, Low-Pressure			red		
Steam, Exhaust	buff	buff pipe and fittings, green bands		black	
Steam, Exhaust and Drips					buff
Steam, Live, to engines, turbines, boiler cross-overs, boiler and main headers		black pipe and fittings, brass bands			
Steam, Boiler Blow-off					
Steam, Drip Lines, including drip receivers' discharge to boilers, blowdowns, reducer lines and manifolds		orange pipe and black fittings			black
Steam, Heating System					light gray
All steam lines not included		buff pipe and fittings, black bands			
Vacuum Return			green		
Vacuum Cleaner			green and red		
Water, Fresh, Low-Pressure	blue			gray	
Water, Fresh, High-Pressure (boiler feed)	blue and white				
Water, Salt	green	light green pipe, black fittings			medium blue
Water, Cistern			white and green		
Water, Tank			white and brown		
Water, Well			yellow and black		
Water, Mill			yellow		
Water, Ontario			brown		
Water, Hemlock			blue		
Water, Cooling			green and black		
Water, Warm, fresh, mains from outlets of jackets and cooling coils to F. W. heaters and hot wells to pumps to feedwater heaters		dark blue-pipe and black fittings			
Water, Feed, from heaters and pumps to boiler drums		Pompeian red pipe and fittings			
Water, Fire Lines, priming lines and all other service using water from fire pumps		permanent vermilion pipe and fittings			
Water, Fire Protection					red
All Fresh-Water Pipe from meters to inlet nozzles for F. W. heaters, water jackets, oil coolers, step-bearing pumps, or to any point where temperature of water changes or mixes with other water		dark blue pipe and P. Verm. fittings			
All Other Water					light blue
Reservoir Return			red and black		

easy one. In fact, one correspondent, Mr. G. E. Sanford, safety engineer of the General Electric Company, remarks that there does not seem to be a sufficient number of satisfactory colors to go around. Two other important considerations in this connection are, first, the tendency of certain colors to fade and in so doing to dangerously approach some other color, thus leading the workman into a false sense of security; and second, the prevalence of color blindness among workers of all classes. On this point Mr. Sanford says:

From my experience in investigating this matter in plants all over the country, I am thoroughly of the belief that the best plan would be to paint a black band a foot more or less long on each side of each union, valve, or at any place where the pipe line could be taken apart, or at any place where attachments could be made. On that black surface should be stenciled in plain white or aluminum letters, at least one inch high where practicable, the name of the material in the pipe, so that markings on overhead lines could be read from the floor in ordinary well-lighted buildings, provided, of course, that the ceiling was not over the average height.

All those who are in any way interested in the solution of this problem would do well to communicate with C. B. LePage, Secretary of Standards and Technical Committees of the A.S.M.E., stating the phase of the problem which interests them most and volunteering all data at their disposal.

Conference of Secretaries of National Standardizing Bodies

The Secretary of the American Engineering Standards Committee, Dr. P. G. Agnew, has recently returned from London where he attended a conference of the secretaries of the national standardizing bodies. This conference was called by the Secretary of the British Engineering Standards Association, Mr. C. le Maistre, and other countries represented were as follows: Belgium, by G. Gerard; Canada, by R. J. Durley; Holland, by E. Hijmans; Norway, by A. Eriksen; and Switzerland, by M. Zollinger. The object of the conference was the interchange of experience and the furtherance of coöperation between the various national bodies in their work of industrial and engineering standardization. After the conference Dr. Agnew visited France, Switzerland, and Germany for a more detailed study of the standardization work in those countries.

It was found that the same general method of procedure is followed in the different countries: namely, technical decisions concerning any specific piece of work are in the hands of a working committee which is so constituted as to be broadly representative, from both the technical and the managerial points of view, of the particular branch of the national industry concerned. This method, the discussion brought out, is followed whether the work is of the nature of specifications, methods of test, or dimensional standardization.

The conference made the following suggestions which will be submitted by the secretaries to their respective organizations for approval.

The conference advocated that for the present coöperation proceed along such informal lines as the interchange of publications, a reciprocal arrangement for making foreign standards available to the industries of each country through their sale by the offices of the national bodies, the exchange of information as to the status of work in progress, etc.

The conference felt that an attempt to form a general international standardizing body should not be made at the present time but in cases in which formal organization should ater be found necessary, the organization should preferably be by subject or industry, somewhat along the lines of the International Electrotechnical Commission.

Arrangements are being made for close coöperation between the national standardizing bodies and the International Chamber of Commerce. A committee has been organized to develop interest in the subject on the part of industrial and commercial interests, and diffuse information on standardization. It is the policy of the International Chamber of Commerce to further the standardization movement by such means, considering only the more general aspects of the problem, and the policies to be followed, leaving the details of industrial standardization to the national bodies, who will coöperate directly with the national organizations of the International Chamber of Commerce in their respective countries.

Rock Island Excursion

(Continued from page 471)

modern equipment and modern methods were shown ready for use in munitions manufacture. Colonel Jordan led the party through the beautifully-laid-out grounds, the well-arranged and maintained 36 acres of storerooms, and the 2400-kw. hydroelectric station operating at 12 ft. head, all on this wooded island of 900 acres in the Mississippi River.

Luncheon was served in the Arsenal cafeteria, after which the party adjourned to Welfare Hall where the opening session of the Ordnance Division was held, with President Carman in the chair. The technical program was contributed by the officers of the Ordnance Department and was illustrated by moving pictures and lantern slides. In the opening paper, Col. C. L' H. Ruggles made a plea for a policy of munitions preparedness which will enable the country to furnish necessary munitions of satisfactory quality at the time and place required by its armies. He advocated the setting aside of money every year for the maintenance of the large stock of munitions which had been made up for use in the world war.

The remainder of the program was made up of five papers dealing with Progress in Ordnance Development Since the Armistice, namely:

Artillery, Major G. F. Jenks
Tanks, Tractors and Trailers, Major L. B. Moody
Artillery Ammunition, Major W. B. Hardig
Small-Arms Machine Guns and Their Ammunition, Major L. O. Wright
Aircraft Armament, Major W. A. Borden.

These papers will be abstracted in a future issue of Mechanical Engineering. Following the technical session, guests were given an exhibition of tractors and tanks in action.

In the evening a dinner was served at the Hotel Blackhawk in Davenport which was attended by the visiting members of the A.S.M.E. and the members of the Tri-Cities engineering societies. Max Sklovsky acted as toastmaster of the banquet and introduced William Butterworth, president of the John Deere Plow Company, who welcomed the guests. President Carman responded for the Society and emphasized the important responsibility of the engineering profession in giving service to the community. Col. A. E. White, president of the American Steel Treaters' Society, made an eloquent address in which he pointed out the necessity for engineering societies to get together for their local activities. He spoke of his experience with the American Steel Treaters' Society, where he found that when engineers in a locality were coöperating the local sections of all of the national societies flourished, and where they did not coöperate the local section of each society was not successful. Calvin W. Rice, Secretary of the Society, Ralph P. Hayes, Chairman of the Davenport Engineering Society, Col. Harry B. Jordan, Commandent at Rock Island Arsenal, and Col. C. L'H. Ruggles of the Ordnance Department, made short addresses.

The following morning a few of the members entered a blind bogie golf tournament held on the Rock Island Arsenal links, Prizes were awarded to J. Edward McDonald, Calvin W. Rice. James F. Lardner, Col. A. E. White, W. H. Kenerson, and H. A. Soverhill. Bert F. Baker, who trailed the field for net score, was awarded a medal on which was significantly inscribed A. A. H. O. G., which interpreted means, Ancient and Honorable Order of Goats. Other of the visitors availed themselves of the opportunity of visiting some of the industrial plants in the locality, leaving for home in the afternoon.

Great credit is due the members of the Tri-Cities Section for the success of an exceedingly interesting two-days' trip. The executive committee of the Tri-Cities Section is: C. R. Adams, Chairman, E. Ransome Jackson, Charles A. Carlson, Clarence W. Fiske, James E. Lardner and H. A. Soverhill.

An Industrial Relations Conference, authorized by Governor William C. Sproul, Pennsylvania, is being arranged by Dr. Clifford B. Connelley, Commissioner of Department of Labor and Industry, Commonwealth of Pennsylvania, to be held at Harrisburg, Pennsylvania, October 24 to 27th.

LIBRARY NOTES AND BOOK REVIEWS

Steam Boiler Engineering

STEAM BOILER ENGINEERING (Helios): A Treatise on Steam Boilers and the Design and Operation of Boiler Plants. Twenty-seventh edition. Heine Safety Boiler Co., St. Louis, Mo., 1920. Cloth, 6 by 9 in., 639 pp., illus., diagrams, charts, tables, $1.75.

The first Helios appeared in July 1893. The present volume is announced as the 27th printing or 13th edition. It is really a new book and a very remarkable book. There is little to remind one of the old Helios other than Colonel Meier's preface and the gilded picture of the sun god with his four-horse chariot on the cover. There are 639 octavo pages and while engineers are used to generosity of this sort from boiler manufacturers, one must marvel that any particular manufacturer can give so much. In fact, if it were not for the acknowledged propaganda of the first section and of occasional passages elsewhere, we should have to call this the best textbook on steam boilers that is available. Naturally, therefore, the book represents to a large extent the results of research and publication by others. It is a thorough and adequate presentation of these results.

The steam tables by Goodenough are used throughout the work. The chapter on piping is excellent, containing perhaps more detail than is to be found in any book not devoted exclusively to this subject, and this detail is presented with a good sense of proportion and the relative importance of the topics included. There is a remarkably extensive index covering 21 pages, and it seems to be a good working index.

Fault can be found with the new Helios as with any other book, and no doubt the next one can be made better. One way of making it better will be to drop the time-honored plan of tabulating analyses of coals by states. This is not a useful way. The argument for such a tabulation should be the field, and subordinate to this the geographical location in the field. Fig. 204 showing the coal fields of the United States is rather carelessly drawn. The illustrations are occasionally arranged out of their numerical sequence. The discussion of superheater design on page 81 refers superficially to the mean temperature difference without giving any careful definition of that term. Among miscellaneous fuels there is no mention of garbage or city refuse. The section on the cost of generating steam is entirely inadequate. The paragraph on page 73 with relation to the steam consumption of large turbines as affected by superheat is almost incomprehensible, but upon careful reading it is possible to guess what the writer intended.—W. D. E.

THE CONSERVATION OF TEXTILES. By Harvey Gerald Elledge and Alice Lucille Wakefield. Laundryowners National Association, La Salle, Ill., 1921. Cloth, 6 x 8 in., 162 pp. illus., $1.

The results of an investigation of the causes of deterioration in textiles, particularly from laundering, accompanied by advice upon conservation.

THE ENGINEER. By John Hays Hammond. Charles Scribner's Sons. New York, 1921. (Vocational series.) Cloth 194 pp., 4 x 7 in., $1.25.

Mr. Hammond's book is intended as guide and counselor for the youth attracted toward engineering as a profession. Its advantages and disadvantages, the qualities required for success, the best kind of education are clearly set forth, followed by chapters which explain the fields occupied by the major divisions of engineering—mechanical, civil, mining, chemical, marine and military. The book is well fitted to assist in the selection of a career.

ENGINEERING CONSTRUCTION. Part 1. In Steel and Timber. By William Henry Warren. Third edition. Longmans, Green and Co., New York, 1921. Cloth, 6 x 9 in., 486 pp., plates, illus., diagrams, $10.

The third edition of this work attempts to include in one volume a summary of the subject: railway and highway bridge design and construction suited for students and engineers. The present edition has been carefully revised, and appendices added on Australian timbers and on recent steel column experiments and formulas.

DIE FORMSTOFFE DER EISEN—UND STAHLGIESSEREI. By Carl Irresberger. Julius Springer, Berlin, 1921. Paper, 6 x 10 in., 245 pp., illus., 24 Marks.

An extensive treatise on molding sands and their preparation for use in iron and steel founding. The occurrence of suitable sands, clays and loams, their mineralogical formations, properties and the methods of testing are described and the added materials, core binders and facings are discussed. Approximately one-half of the volume is devoted to the questions of drying, grinding and mixing molding sands, the purification of used sand, automatic sand-mixers, etc.

FUNFSTELLIGE TAFELN DER KREIS- UND HYPERBELFUNKTIONEN. By Keiichi Hayashi. Berlin, Walter de Gruyter & Co., 1921. 182 pp., 9 x 6 in., paper.

The values given in this table are in ten-thousandths from 0 to 0.1, in thousandths from 0.1 to 3, in hundredths from 3 to 6.3 and in tenths from 6.3 to 10. The circular and hyperbolic functions of any number are printed side by side, making it unnecessary to consult two places when using formulas containing both functions.

LUBRICATING AND ALLIED OILS. By Elliott A. Evans. E. P. Dutton & Co., New York, 1921. (The Directly-Useful Technical Series.) Cloth, 6 x 9 in., 128 pp., illus., $4.

This handbook describes the chemical and physical tests commonly used for determining the properties of a lubricating oil, and discusses those branches of the subject which are of interest. The book is intended to assist chemists in compiling specifications and examining lubricating oils, and to give engineers an insight into the properties and applications of such oils, and the interpretation of specifications.

THE MICROSCOPE; ITS DESIGN, CONSTRUCTION AND APPLICATIONS. Edited by F. S. Spiers. J. B. Lippincott Co., Philadelphia, 1920. Cloth, 7 x 10 in., 260 pp., plates, diagrams, $5.

This volume contains the papers and addresses delivered at a meeting held in January 1920, at the initiative of Sir Robert Hadfield, by the Faraday Society, the Royal Microscopical Society, the Optical Society and the Photomicrographic Society. One purpose of the symposium was to stimulate the study of and research in microscopical science by indicating lines of progress in the design of the instrument, showing recent improvements in the microscope and its technique, and its varied uses as an instrument of research. The papers cover a wide field, including among other subjects the mechanical design, optics and manufacture of microscopes; their applications, especially in metallography, metallurgy, engineering and meteorology; their testing. An historical introduction is given and a bibliography of the chief literature.

NATIONAL ELECTRICAL SAFETY CODE. Issued by U. S. Bureau of Standards. Third edition. Wash., Govt. Printing Office, 1921. (Handbook series, no. 3.) Cloth, 5 x 8 in., 366 pp., $0.40.

About four years ago the Bureau of Standards published the completed text of this Code for examination and trial use, an early revision being contemplated. War conditions interfered with this trial, so that the publication of a new edition has been greatly delayed. The revision is now completed and the revised code is now published in this handbook for more convenient use. The discussion of the rules has been segregated under a separate cover so as to reduce the bulk of the main volume, and will appear as Bureau of Standards Handbook No. 4, now in press.

OIL FUEL. By Edward Butler. Fourth edition. J. B. Lippincott Co., Philadelphia, 1921. Cloth, 5 x 8 in., 310 pp., illus., $3.75.

This book is intended as an exhaustively and systematically classified record of the developments and progress in the application of oil fuel for all steam raising, metallurgical and other purposes, except internal-combustion engines, for which liquid fuel can be used successfully.

THE OPEN HEARTH; ITS RELATION TO THE STEEL INDUSTRY, ITS DESIGN AND OPERATION. First edition. The Wellman-Seaver-Morgan Co., Cleveland, 1920. Cloth, 9 x 11 in., 378 pp., illus., $7.50. (Sold by U. P. C. Book Co., Inc., N. Y.)

This is a practical book on the design and construction of the open-hearth furnace, and on its use in modern steel making. The methods of working, the gas producers, metal mixers, charging machines and other auxiliaries are described, so that the volume forms a complete, though brief account of open-hearth practice, very fully illustrated by drawings, half-tones and tables of data.

PERSONNEL RELATIONS IN INDUSTRY. By A. M. Simons. The Ronald Press Co., New York, 1921. Cloth, 6 x 9 in., 341 pp., $3.

The first part of this work gives a survey of the situation in American industry and analyzes the elements of the employment problem. The specific stages through which the questions at issue have passed are then reviewed, after which the author summarizes the best recent thought on the broad question of democracy in industry. Throughout the author has tried to call attention to the scientific laws that have merged from recent study of the subject, and to determine the reactions of human nature to the conditions presented in the various industrial problems.

DIE PRAKTISCHE NUTZANWENDUNG DER PRUFUNG DES EISENS DURCH AETZVERFAHREN UND MIT HILFE DES MIKROSKOPES. By E. Preuss. Second edition. Julius Springer, Berlin, 1921. Paper, 6 x 9 in., 124 pp., illus., 14 Marks.

The present book is intended as a guide in the practical use of microscopic methods of testing the quality of iron, of sufficient scope to meet the ordinary needs of steel-works metallurgists and testing engineers. The methods of etching and polishing are given, and the useful tests for determining structure, controlling heating, tempering, etc. are described.

RELATIVITY, THE ELECTRON THEORY AND GRAVITATION. By E. Cunningham. Second edition. Longmans, Green and Co., New York, 1921. Cloth, 6 x 9 in., 148 pp., $3.50.

The primary purpose of this monograph was to set out as clearly and simply as possible the relation of the principle of relativity to the electron theory, in a way useful to the general reader and especially to the experimental physicist. In the present edition a second section has been added, which presents the general principle in its present form.

SHEET-METAL DRAFTING. By Ellsworth M. Longfield. First edition. McGraw-Hill Book Company, Inc., New York, 1921. (Industrial education series.) Cloth, 6 x 9 in., 236 pp., illus., $2.25.

This text was prepared especially for correspondence-study instruction in the Extension Division of the University of Wisconsin. It is also adapted as a textbook for vocational schools. The underlying principles of sheet-metal pattern drafting are presented, the principles being arranged in sequence with due regard to the factors governing the student's progress through a course of instruction.

SMALL MOTORS, TRANSFORMERS, ELECTROMAGNETS. By H. M. Stoller, F. E. Austin, E. W. Seeger. American Technical Society, Chicago, 1920. Cloth, 6 x 8 in., 320 pp., illus., $3.

The first section of this book discusses small motors, automobile starting motors and charging generators and farm lighting outfits. Typical designs are given for d.c. motors of all standard voltages, ranging from 0.01 hp. to 0.5 hp. in size, and for a.c. induction motors from 0.125 to 0.5 hp. in size.

The second section, on small low-tension and high-tension transformers, treats of those which will transform from 110 to 220 volts and down to the lower voltages. The concluding section includes typical designs of electromagnets for direct and alternating current work and induction coils. Flat-plunger, cone-plunger, horseshoe and clapper electromagnets and portative magnets are considered.

STATIQUE GRAPHIQUE ET RESISTANCE DES MATERIAUX. By Louis Roy. Gauthier-Villars et Cie, Paris, 1921. (Cours de mécanique appliquée, 2.) Paper, 6 x 10 in., 213 pp., 30 francs.

This volume on graphic statics and resistance of materials is the second of a series of volumes by professors in the Institute of Electrotechnics and Applied Mechanics of the University of Toulouse, presenting the course in applied mechanics given to students at the Institute. The author has attempted to present the subject as rigorously as its nature permits and to cover completely those applications of actual interest to the engineer. By omission of other questions, the text has been compressed to moderate size.

TELEPHOTOGRAPHY. By Cyril F. Lan-Davis. Second edition, by L. B. Booth. E. P. Dutton & Co., New York, 1921. Cloth, 5 x 7 in., 116 pp., Illus., plates, $2.00.

The book expounds the theory of telephotography, describes the commercial lenses and gives the practical methods in careful detail. The various applications are fully illustrated.

THE THIRD POWER KINK BOOK. Compiled by the editorial staff of Power. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth 6 x 9 in., 264 pp., illus., $1.50

A collection of some three hundred unconventional but practical ways of meeting power-plant emergencies, of the kind that arise in operation and in repair work.

THOMAS' REGISTER OF AMERICAN MANUFACTURERS. Twelfth edition. Thomas Publishing Co., New York. 19 x 10 Cloth, 10 x 12 in., $15.

The twelfth edition of this popular directory of manufacturers and dealers presents no novelties in arrangement or contents. According to its publishers, however, over 200,000 changes have been made in order to keep the lists complete and accurate. The Register is a directory of first hands in all lines, classified under several thousand subjects and fully indexed, so that the makers of any article may readily be found. Companies are also listed alphabetically, with data upon branch offices, capital, location, etc. A list of trade names is given, showing the owners of the various trade marks. In addition to these main divisions, the Register also contains lists of representative banks, commercial organizations, exporters and importers, and trade papers, making it a most complete work of reference for buyers and sellers.

LA THEORIE DE LA RELATIVITE RESTREINTE ET GENERALISEE. By A. Einstein. Gauthier-Villars et Cie, Paris, 1921. Paper, 5 x 7 in., 120 pp., 7 francs.

This French edition of Dr. Einstein's popular presentation of the theory of relativity is based on the second German edition. A lengthy preface by Emile Borel discusses the value of the theory and the limits of its practical use.

UNITED STATES STEEL—A CORPORATION WITH A SOUL. By Arundel Cotter. Doubleday, Page and Co., Garden City, N. Y., 1921. Cloth, 6 x 8 in., 312 pp., portraits, plates, $3.

This is an enlarged and modernized edition of The Authentic History of the United States Steel Corporation. It gives a well written account of the reasons for its organization, its history, activities, aims and policies, relations with its employees, together with some account of important officials, past and present.

DIE WARMEVERLUSTE DURCH EBENE WANDE UNTER BESONDERER BERÜCKSICHTIGUNG DES BAUWESENS. By Karl Hencky. R. Oldenbourg, München und Berlin, 1921. Paper, 7 x 10 in., 124 pp., illus., tables, 26 marks.

This work is based on extensive experiments on the heat conductivity of walls of the usual types and of the customary building materials, carried out at the Munich Technical High School. From the results of these and general laws of the conduction of heat, the author has formulated equations to be used in designing heating installations. The book is intended for architects and for engineers engaged in the design of heating plants, as a practical aid in calculating the size of installations.

WIRTSCHAFTLICHE VERWERTUNG DER BRENNSTOFFE. By G. de Grahl. Second revised edition. R. Oldenbourg, München and Berlin, 1921. Paper, 8 x 11 in., 485 pp., plates, illus., charts, diagrams, 110 marks.

This work on the economical utilization of fuels first appeared in 1915, when the economic isolation of Germany began to be effective. The present edition has been entirely rewritten in the light of the fuel situation after the war, and is an exhaustive treatise on the utilization of the available fuel supply under present conditions. After a description of the solid, gaseous and liquid fuels, in which their efficiencies are compared, the author discusses the processes for converting and enriching them. Gas production, by-products, nitrogen utilization are treated in detail. The subject of combustion is then taken up, and an extended critical discussion of methods of firing, especially for steam production, is included. Another chapter discusses heating for municipalities, waste heat utilization, etc. The concluding chapter treats of the economies of energy in general.

WIRELESS TELEGRAPHY WITH SPECIAL REFERENCE TO THE QUENCHED-SPARK SYSTEM. By Bernard Leggett. E. P. Dutton & Co., New York, 1921. (The Directly-Useful Technical Series.) Cloth, 6 x 9 in., 485 pp., illus., plates, $12.

This volume is intended to provide a treatise in English on radiotelegraphy in which particular attention is given to the quenched-spark system. Bibliographies are appended to many chapters.

THE ENGINEERING INDEX

(Registered U. S. Patent Office.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photostatic copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents per page, plus postage. A separate print is required for each page of the larger periodicals, but wherever possible two small or medium-sized pages will be photographed together on the same print. The bill will be mailed with the print. When ordering photostats identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ACCIDENTS

Dust Explosions. An Explosion of Hard Rubber Dust, David J. Price and Hylton R. Brown. Chem. & Metallurgical Eng., vol. 24, no. 17, April 27, 1921, pp. 737–740, 5 figs. Results of investigation of recent explosion in reduction of hard-rubber scrap department of large industrial plant. Recommendations for prevention and precautions to be taken in hard-rubber grinding.

AERODROMES

France. French State Aerodromes for Civil Use. Aviation, vol. 10, no. 20, May 16, 1921, pp. 638–639, 6 figs. Types of aerodrome built by French government.

AERODYNAMICS

Wind-Tunnel Experiments. Extract from a Report of the Resistance of Spheres of Small Diameter in an Airstream of High Velocity, Capt. Toussaint and Lieut. Hayer. Aerial Age, vol. 13, no. 9, May 9, 1921, pp. 199–200, 3 figs. Interpretation of results found in wind-tunnel experiments at Aerotechnical Inst. of Saint-Cyr, France, and comparison with results found by other experimenters.

AERONAUTICAL INSTRUMENTS

Accelerometer. Accelerometer Design, F. H. Norton and Edward P. Warner. Nat. Advisory Committee for Aeronautics, no. 100, 1921, 16 pp. 14 figs. Experimental work carried out by technical staff of Nat. Advisory Committee for Aeronautics for the purpose of recording errors due to accelerations acting in other than required direction and also errors due to angular accelerations.

Driftograph. The Driftograph. Sci. Am. Monthly, vol. 3, no. 5, May 1921, pp. 453–454, 1 fig. Instrument for determining drift of aircraft. Translated from Génie Civil.

AERONAUTICS

National Advisory Committee. Special Report of the National Advisory Committee for Aeronautics. Aviation, vol. 10, no. 18, May 2, 1921, pp. 553–558. Federal regulation of air navigation; air routes to cover whole U. S.; coöperation among government departments. Submitted to President of U. S., April 9, 1921.

Special Report of the National Advisory Committee for Aeronautics. Aerial Age, vol. 13, no. 9, May 9, 1921, pp. 200–202. (Concluded.)

Reactive Propulsion in Air. Possibility of Reactive Propulsion in Air, B. T. Koleroff. Aviation, vol. 10, no. 20, May 16, 1921, pp. 624–625. Underlying principles to which device operating by reactive propulsion must conform.

Research Laboratory. The Aeronautic Research Laboratory at the Institute of St. Cyr, John Jay Ide. Automotive Industries, vol. 44, no. 16, April 21, 1921, pp. 853–855, 5 figs. Facilities for aerodynamic investigations include two wind tunnels of different size, whirling arm, and two electrically operated trucks running on rails, all of which are equipped for determining characteristics of airfoils. One truck is designed for testing propellers.

Tests. Review on Experimental Aerotechnics (Revue d'aérotechnique expérimentale), L. Toussaint. Revue générale des Sciences, vol. 32, no. 7, April 15, 1921, pp. 203–213, 2 figs. Aerodynamic principles experimentally established at principal aeronautical laboratories of the world.

AEROPLANE ENGINES

Cooling Systems. Cooling System Flight Test of Loening M-8. U. S. War Dept., Air Service Information Circular, vol. 3, no. 206, April 30, 1921, 8 pp. 5 figs. Object was to determine effectiveness of cooling system of Loening monoplane, model M-8.

Design. The Ultimate Airplane Engine, Jesse G. Vincent. Aviation, vol. 10, no. 18, May 2, 1921, pp. 567–569. Possibilities of utilizing steam engine, steam turbine or electrical propulsion for aeroplane propulsion.

Exhaust Silencer. The Martin Exhaust Silencer. Aeronautics, vol. 20, no. 392, April 21, 1921, pp. 278, 2 figs. Silencer built of light-gage iron sheet, riveted and welded together.

Haacke. The Haacke 30 H. P. Aero Engine. Flight, vol. 13, no. 14, April 7, 1921, pp. 239–240, 5 figs. Two-cylinder opposed air-cooled model developing 30 hp.

Liberty. Performance of a Liberty 12 Airplane Engine, S. W. Sparrow and H. S. White. Nat. Advisory Committee for Aeronautics, no. 102, 1921, 20 pp. 16 figs. Tests conducted in altitude chamber of dynamometer laboratory of Bur. of Standards. Engine was tested under full power run at ground altitude at speeds from 1200 to 2000 r.p.m. and at speeds at 1600 and 1700 r.p.m. at full throttle from ground altitude to 25,000 ft. in steps of 5000 ft. Propeller-load runs and friction-horsepower runs were also examined.

Test of a Standard Liberty Cylinder Mounted on a Universal Engine Crank Case. U. S. War Dept., Air Service Information Circular, vol. 2, no. 199, April 25, 1921, 10 pp. 6 figs. Measurement of power friction losses, temperatures and heat-transfer characteristics of standard Liberty cylinder when mounted on universal engine.

Napier "Cub." The Napier "Cub" Engine. Automobile Engr., vol. 11, no. 149, April 1921, pp. 146–147, 2 figs. Four sets of four cylinders. Included angle between uppermost blocks of cylinders is 52 1/2 deg. and between bottom blocks 127 1/2 deg. Engine develops 1000 hp.

Operation with Automobile Gasoline. Operating Liberty "12" and Wright-Hispano 300-Hp. Engines on Automobile Gasoline. U. S. War Dept., Air Service Information Circular, vol. 3, no. 227, May 10, 1921, 4 pp. It is recommended that use of such fuel in engines should be avoided whenever possible and in cases of necessity engines should be run throttled while on or near ground.

Performance. Investigation of the Effect of Air Conditions Upon the Power of Aviation Engines, Harold S. White. Armour Engr., vol. 12, no. 3, Mar. 1921, pp. 135–144, 3 figs. Investigations of theory establishing that power is proportional to density or inversely proportional to absolute temperature. Development of new theory.

Some Factors of Airplane Engine Performance, Victor R. Gage. Nat. Advisory Committee for Aeronautics, Report No. 108, 1921, 29 pp., 28 figs. Tests on Liberty 12 and three models of Hispano-Suiza made in altitude chamber where conditions simulated altitudes up to about 30,000 ft. at engine speeds ranging from 1,200 to 2200 r.p.m.

Power at High Altitudes. Influence of Flight at High Altitudes on Power of Aeroplane Engines (Influence du vol à haute altitude sur la puissance du moteur d'un aéroplane), M. Collette. Arts et Métiers, vol. 74, no. 2, Feb. 1921, pp. 49–51, 4 figs. Graph for determining altimetric reduction of power of aeroplane engines from temperature and barometric pressure.

AEROPLANE PROPELLERS

Design. Aeronautic Propeller Design, F. W. Caldwell. Jl. Soc. Automotive Engrs., vol. 8, no. 5, May 1921, pp. 467–480, 26 figs. Propeller-design theories and aerodynamic principles are discussed mathematically, as well as elements governing best propeller diameter for obtaining highest thrust. Consideration is given in detail to adjustable-pitch and reversible propellers as well as to those made up of laminations or sheets of paper or fabric impregnated with bakelite as binder.

Variable-Pitch. The Parker Variable Pitch Airscrew. Flight, vol. 13, no. 15, April 14, 1921, pp. 257, 2 figs. Pitch changes automatically as density of air decreases with altitude, also when engine misfires or slows down.

AEROPLANES

Aerofoils. Aerodynamic Characteristics of Aerofoils. Nat. Advisory Committee for Aeronautics, report no. 93, 1921, 83 pp, 218 figs. Collection of data on aerofoils from published report of leading aerodynamic laboratories of U. S. and Europe. Charts and tables for use of designing engineers and for general reference.

The German Lachmann Slotted Aerofoil. Flight, vol. 13, no. 14, April 7, 1921, pp. 242, 2 figs. Translated from Flugsport.

The Resistance of Aerofoils, W. F. Gerhardt Aerial Age, vol. 13, no. 8, May 2, 1921, pp. 175–178, 13 figs. Methods of plotting aerofoil characteristics, (Concluded.)

All-Metal. German All-Metal Commercial Machines, Alfred Gradenwitz. Aeronautics, vol. 20, no. 394, May 5, 1921; pp. 314–316, 5 figs. Dornier types.

The New German All-Metal Aeroplanes (Les nouveaux avions métalliques allemands), E. H. Lémonon. Aerophile, vol. 29, nos. 5–6, Mar. 1–15, 1921, pp. 71–78, 16 figs. Junkers types.

Design. Influence of Span and Load Per Square Meter on the Air Forces of the Supporting Surface, A. Betz. Aerial Age, vol. 13, no. 10, May 16, 1921, pp. 224–225, 4 figs. Formulas. Translated from Technische Berichte.

Load Factors. Aeronautics, vol. 20, no. 391, April 14, 1921, pp. 254–255. Scale of load factors and factors of safety prepared by British Advisory Committee for Aeronautics.

Flight Endurance. Notes on Airplane Flight Endurance. U. S. War Dept., Air Service Information Circular, vol. 3, no. 210, May 1, 1921, 6 pp., 1 fig. Chart for determining minimum horsepower required or maximum horsepower available at any altitude that aeroplane can reach.

Flight Without Propellers. New Air Transport Theory, Harry Harper. Motor Transport, vol.

Note.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

32, no. 843, April 25, 1921, pp. 442–443. Pulsating wing invented by Prof. Raimund Nimfuhr. Wing is hollow with air bags inside, underneath section taking form of flexible membrane, which can be set beating or pulsating by action of pneumatic pumps which alternately fill or empty air bags. Aeroplane without propellers, impelled by pulsating wing, is to be manufactured by American syndicate.

Hispano-Suiza. Performance of a 300-Horsepower Hispano-Suiza Airplane Engine, S. W. Sparrow and H. S. White. Nat. Advisory Committee for Aeronautics report no. 103, 1921, 22 pp. 16 figs. Test showed inadequacy of carburetor altitude control of air-fuel ratio for heights above 20,000 ft.

Saulnier. The R. Saulnier Triple-Motored Monoplane (Le monoplan trimoteur R. Saulnier). Aérophile, vol. 29, nos. 5–6, Mar. 1–15, 1921, pp. 67–69, 6 figs. Characteristics: Engines, 3 Lorraine-Dietrich of 370 hp. each; weight loaded, 7000 kg.; useful weight, 2700 kg.

Strutless Supporting Planes. Aeroplanes with Strutless Supporting Planes (Flugzeuge mit verspannungslosen Tragflächen), E. Meyer. Schweizerische Bauzeitung, vol. 77, no. 15, Apr. 9, 1921, pp. 166–168, 7 figs. Points out aerodynamic superiorty of aeroplanes with freely supported strutless planes based on the Junkers principle, and refers to various recent commercial and sport types constructed with view to reducing the resistance-producing parts to a minimum.

Struts. The Design of Long Struts Exposed to the Air, John Case. Aeronautics, vol. 20, nos. 391 and 392, April 14 and 21, 1921, pp. 257–258, 4 figs., and 272–274, 5 figs. Apr. 14: formulas for computing dimensions of different types. Apr. 21: Method of designing taper struts having parallel hole.

[See also HELICOPTERS; PARACHUTES, SEAPLANES.]

AIR

Moisture Content. The Moisture Content of Atmospheric Air (Der Wasserdampfgehalt der Luft), Karl Reyscher. Gesundheits-Ingenieur, vol. 44, no. 15, Apr. 9, 1921, pp. 168–170, 1 fig. Values for pressures in saturated steam, weight of steam and of pure air, etc. are given in tabular form from which curves are developed.

AIR MACHINERY

Classification. Classification and Nomenclature of Air Machinery (Gliederung und Bezeichnung der Luftfördermaschinen), M. Berlowitz. Gesundheits-Ingenieur, vol. 44, no. 13, Mar. 26, 1921, pp. 141–143, 1 fig. Suggestions for a standardization of terms for pumps and compressors.

AIRCRAFT CONSTRUCTION MATERIALS

Brazing. Report on Investigation of Dip Brazing with 80–20 Brass. U. S. War Dept., Air Service Information Circular, vol. 3, no. 203, April 30, 1921, 8 pp. 8 figs. Objects were to determine best flux to use in brazing and effects of heat treatment on brazed joints, and to develop satisfactory method of brazing with 80 per cent copper and 20 per cent zinc mixture.

Plywood. Plywood in Airplane Construction, Armin Elmendorf. Aviation, vol. 10, no. 21, May 23, 1921, pp. 660–663, 7 figs. Uses in construction of semi-monocoque fuselage. Table of weights of veneer. (Concluded.)

AIRSHIPS

German. Development and Present Status of German Airships. Automotive Industries, vol. 44, no. 20, May 19, 1921, pp. 1057–1065, 1 fig. Tables giving characteristics of German airships built up to May 1921. Survey of technical successes and failures of various types. Comparison of performance of R-34 with that of German L-59 which made trip to East Africa.

Hangars. See HANGARS.

Mooring Gear. Airship Mooring Gear. Engineering, vol. 111, no. 2884, April 8, 1921, pp. 423–424 and 426, 4 figs. Experimental mooring mast designed and installed by British Air Ministry.

An American System of Airship Mooring. Aeronautics, vol. 20, no. 391, April 14, 1921, p. 256, 4 figs. Airship is anchored to 5 trolleys running under circular slots in platform.

Mooring Masts for Airships. Aviation, vol. 10, no. 21, May 23, 1921, p. 665, 1 fig. Webbed-steel structure 115 ft. in height, with revolving circular platform housed-in at top and above platform mooring. Apparatus of cylindrical form swung on gimbals, which permits ship when moored to sway with wind. Mast erected at Pulham, England.

R-36. The Passenger-Carrying Airship R-36. Engineering, vol. 121, no. 2885, April 15, 1921, pp. 454–456 and 458, 28 figs. partly on supp. plate. Characteristics: Overall length, 672 ft. 2 in.; maximum diameter of hull, 78 ft. 9 in.; height from bumping bags to top of hull structure, 91 ft. 7 in.; gas capacity, 2,196,000 cu. ft.; carried in 19 bags; gross lift, 64.5 tons.

Rigid. Circumferential Wiring of Rigids, E. H. Lewitt. Aeronautics, vol. 20, no. 395, May 12, 1921, pp. 336–338, 8 figs. Study of stresses.

[See also AERODROMES.]

ALCOHOL

Coke-Oven Gas. The Manufacture of Alcohol from Coke-Oven Gas, C. F. Tidman. Jl. Soc. Chem. Industry, vol. 40, no. 8, April 30, 1921, pp. 86T–89T, 2 figs. Record of work carried out at Skinningrove Iron Works, England.

Industrial. Industrial Alcohol (L'alcool industriel), Charles Blanchet. Revue de l'Ingenieur et Index technique, vol. 28, no. 4, April 1921, pp. 179–185. Requirements for manufacture of industrial alcohol. Possibility of utilizing alcohol as automobile fuel. (To be continued.)

Industrial Alcohol and Prohibition Enforcement, Martin H. Ittner. Chem. Age (N. Y.), vol. 29, no. 6, June 1921, pp. 211–212. Resolutions adopted by Am. Chem. Soc. urge that all legislation for enforcement of prohibition "be so clearly drawn as not to restrict the activities of legitimate industries which must have industrial alcohol."

ALLOY STEELS

Chromium-Tungsten. Constitution of Chromium: Tungsten Steels. Chem. & Metallurgical Eng., vol. 24, no. 18, May 4, 1921, pp. 791–793, 8 figs. Recent Japanese work throwing light upon complex reactions giving self-hardening and red-hardness properties to modern high-speed steels. From Sci. Reports of Tohoku University.

ALLOYS

See ALUMINUM ALLOYS; ZINC ALLOYS; BEARING METALS; BRONZES; COPPER ALLOYS; GUN METAL; PHOSPHOR BRONZE.

ALUMINUM

Casting Losses. Losses in Aluminum and Aluminum-Alloy Melting, Robert J. Anderson, U. S. Dept. of Interior, Bur. of Mines, Reports of Investigations, no. 2239, April 1921, 6 pp. Factors in operation of furnaces that affect casting losses.

ALUMINUM ALLOYS

Melting Practice. Iron-Pot Melting Practice for Aluminum Alloys, Robert J. Anderson. Metal Industry (N. Y.), vol. 19, no. 5, May 1921, pp. 189–190. Design of iron-pot furnaces.

AMMONIA CONDENSERS

Selection. The Proper Selection of Ammonia Condensers, W. H. Motz. Power, vol. 53, no. 17, April 26, 1921, pp. 659–662, 4 figs. Economic considerations.

ANEMOMETERS

Comparison of. Comparison of Anemometers (Sur la comparabilité des anèmomètres), M. C.-E. Brazier. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 14, April 4, 1921, pp. 843–845. Comparison of various types in currents of air inclined at an angle.

APPRENTICES, TRAINING OF

Methods. Programs of Apprenticeship and Special Training in Representative Corporations—XII, J. V. L. Morris. Am. Mach., vol. 54, no. 18, May 5, 1921, pp. 778–779, 4 figs. Method of training apprentices at plant of Packard Motor Car Co., Detroit, Mich.

National Instructional Factories. Industrial Training. Times Eng. Supp., no. 558, April 1921, p. 132. Discusses organization of national instructional factories for training and education industrial apprentices.

Railways. Paris-Orleans Apprentice Work Organized. Ry. Mech. Engr., vol. 95, no. 5, May 1921, pp. 313–316, 4 figs. Description of development of courses for apprentices of Paris-Orleans during war. Translated from Revue Générale des Chemins de Fer.

AUTOGENOUS WELDING

German Code, Revised. Revision of Acetylene Code (Abänderung des Entwurfes der Acetylenverordnung). Autogene Metallbearbeitung, vol. 14, no. 7, Apr. 1, 1921, pp. 98–107. Proposal is result of conference of members of German Acetylene Assn. for Autogenous Metalworking, Federation of German Autogene Industry, and government officials, and represents a complete revision of existing code of 1914 and of proposal of Bavarian Government.

AUTOMOBILE ENGINES

Carburetors. See CARBURETORS.

Heavier Oil Fuels, Use of. Experiences with the Use of Heavier Oil Fuels in Automobile Engines (Erfahrungen und Erwägungen über die Verwendung schwererer Brennstoffe im Automobilmotor), J. Plünzke. Motorwagen, vol. 24, nos. 8 and 9, Mar. 20 and 31, 1921, pp. 150–158 and 169–178, 41 figs. Discussion, based on experience, of means of improving carburetor type of engine for rational use of medium-weight in place of light oils.

Highway. Non-Detachable Head Used in New Stock Engine, J. Edward Schipper. Automotive Industries, vol. 44, no. 16, April 21, 1921, pp. 844–846, 4 figs. Engine manufactured by Highway Engine Co. has four cylinders, 3¾ by 5 in., and develops maximum of 48 hp. Both halves of crankcase and water-jacket cover are aluminum castings. Valve caps are screwed into cylinder head. Full pressure lubrication employed.

Valves, Grinding-in. Electric Machines for Grinding-in Valves. (Elektrische Ventileinschleifmaschine), H. Seiler. Allgemeine Automobil-Zeitung, vol. 22, no. 5, Jan. 29, 1921, p. 29, 2 figs. Describes German patented machine which can also be used as a drilling machine and consists mainly of a small electric motor of 1/15 to 1/20 hp. with the necessary gear.

AUTOMOBILE FUELS

Characteristics. The Character of Various Fuels for Internal Combustion Engines—III, H. T. Tizard and D. R. Pye. Automobile Engr., vol. 11, no. 149, April 1921, pp. 134–137, 2 figs. Influence of specific heat and dissociation of working fluid. Calculation of final temperature and work done during expansion.

Research. Résumé of Bureau of Standards Fuel Study, H. C. Dickinson. Jl. Soc. Automotive Engrs., vol. 8, no. 5, May 1921, pp. 482–486, 6 figs. Two types of experiments were undertaken; steady runs to determine rate of fuel consumption under load conditions, at about one-fifth maximum mean effective pressure and speed of 1200 r.p.m., and series of repeated accelerations from 10 to about 30 m.p.h. In each case fuel consumption was recorded.

The Influence of Various Fuels on the Performane of Internal Combustion Engines—III and IV, H. R. Ricardo. Automobile Engr., vol. 11, nos. 149 and 150, April and May 1921, pp. 130–133, 5 figs., and 169–175, 14 figs. April: Experimental study of relationship between detonation point and spontaneous ignition temperature. May: Experimental investigation of power output from different fuels, with constant and with adjusted compression ratios.

The Influence of Various Fuels on Engine Performance—II and III, H. R. Ricardo. Automotive Industries, vol. 44, nos. 16 and 19, April 21 and May 12, 1921, pp. 856–862, 6 figs., and 1003–1007, 12 figs. Research on detonation and effect thereon of combustion chamber design, turbulence, speed of rotation, temperature and pressure are discussed at length, and measurement of value of fuel in terms of its tendency to detonate are tabulated and plotted in their relation to other important factors.

[See also ALCOHOL.]

AUTOMOBILES

Bodies. Automobile Body Construction, P. E. Stone. Jl. Soc. Automotive Engrs., vol. 8, no. 5, May 1921, pp. 404–409. Notes on strength and desirability of materials suitable for construction of enclosed type of body.

Some Examples of Modern Passenger Car Bodies Designed in Germany, Benno R. Dierfeld. Automotive Industries, vol. 44, no. 17, April 28, 1921, pp. 897–899, 11 figs. Designs embodying V-type radiator and windshield, concealed top and divided rear seat.

Cleaning Parts for Repair Work. Modern Boiling Apparatus for Automobile Factories and Repair Workshops (Neuzeitliche Abkochanlagen für Automobilfabriken und Ausbesserungswerkstätten), H. Toepel. Automobil-Rundschau, vol. 20, no. 5–6, Mar. 1921, pp. 53–55, 3 figs. Details of vats patented by Hannover Machine Constr. Corp. (Hanomag) for cleaning of automobile parts preliminary to repair work by boiling in lye.

Fuel Cocks. The Pallas Fuel Cock as Protection Against Theft of Automobiles (Der verschliessbare Pallas-Brennstoffhahn), E. Jaenichen. Allgemeine Automobil-Zeitung, vol. 22, no. 7, Feb. 12, 1921, p. 27, 2 figs. Describes fuel cock, connecting in fuel pipe to carburetor, which can be closed and opened with a key, construction being such that key fits only the one cock for which it is intended.

Manufacture. A Modern Automobile Factory. Eng. Production, vol. 2, no. 31, May 5, 1921, pp. 575–583, 26 figs. Production methods at works of Arrol-Johnston, Dumfries, Scotland.

Special Machines and Fixtures in the Franklin Plant, Franklin D. Jones. Mach. (N.Y.) vol. 27, no. 9, May 1921, pp. 823–830, 19 figs. Mechanical equipment designed either to increase production, perform special operations, or maintain established standards of accuracy.

Wrenches. Manufacture of Socket Wrenches, P. Baldus. Machy. (N.Y.), vol. 27, no. 9, May 1921, pp. 868–869, 4 figs. Practices of various automobile manufacturers.

AVIATION

Aerial Lighthouses. The Aerial Lighthouse. Flight vol. 13, no. 16, April 21, 1921, pp. 280–283, 7 figs. Suggested design.

Canadian Air Board. Report of the Canadian Air Board for the Year 1920. Flying, vol. 10, no. 4, May 1921, pp. 139–143. Board was created (1) to regulate civil aviation, (2) to conduct civil government operations, and (3) to develop air defense of Canada, including organization and administration of Canadian Air Force.

Commercial. European Air Lines. Aeronautics, vol. 20, no. 395, May 12, 1921, pp. 332–334, 6 figs Air routes which are now in operation in Europe, with fare tariffs and timetables.

Landings, Marking. Air Service Adopts Location Marker. Aviation, vol. 10, no. 17, April 25, 1921, p. 527, 2 figs. Specifications of locations marker adopted by U. S. Air Service.

Mail Service. Three Years of Air Mail Service. Aviation, vol. 10, no. 18, May 2, 1921, pp. 559–564, 5 figs. Comparison of performance of U. S. Air Mail Service and of British and Canadian civil flying.

National Advisory Committee for Aeronautics. Special Report of the National Advisory Committee for Aeronautics. Aerial Age, vol. 13, no. 8, May 2, 1921, pp. 178–180. Federal regulation of air navigation. Air routes to cover whole U. S. Coöperation among government departments.

Soaring Flight. The Soaring Flight of Birds and the Possibility of a Mechanical Imitation. (Der Segelflug der Vögel und die Möglichkeit einer Künstlichen Nachahmung), Carl Steiger. Schweizerische Bauzeitung, vol. 77, no. 15, Apr. 9, 1921, pp. 168–169. Critical discussion of Lillienthal's paper with above title reported in same journal (nos. 11 and 12, Mar., 1921).

Speed of Flights. The Question of Speed (Le problème de la vitesse), J. Philippe. Aéronautique, vol. 3, no. 22, Mar. 1921, pp. 136–137. Theoretical conditions necessary for obtaining high horizontal speed.

B

BEARING METALS

Anti-Friction. Anti-Friction Bearing Metals, P. W. Priestley. Metal Industry, (Lond.), vol. 18, no. 17, April 29, 1921, pp. 323–324. Typical compositions of anti-friction methods employed in construction of aeroplanes and automobile engines.

Research. Results of Investigation Covering Bearing Metals. Belting, vol. 18, no. 4, April 1921, pp. 63–64. Report of committee on mechanical standards, Canadian Pulp & Paper Assn., at recent Montreal convention.

BEARINGS

Examination. A Microphone "Stethoscope" for Bearings. Engineering, vol. 111, no. 2888, May 6, 1921, pp. 546, 3 figs. Apparatus for examining condition of bearings and gears by electricity.

BEARINGS, BALL

Manufacture. The Ball Bearing—I, Henry L. Heathcote. Machy. (Lond.), vol. 18, no. 448, April 28, 1921, pp. 114–119, 3 figs. Notes on manufacture and testing.

The Ball Bearing: In the Making, Under Test and on Service, Henry L. Heathcote. Automobile Eng., vol. 11, no. 150, May 1921, pp. 180–187, 6 figs. Mathematical study of action of ball bearings, together with notes on their manufacture and suggested method of testing them.

The Manufacture of Ball Bearings. Engineering, vol. 111, nos. 2884 and 2885, April 8 and 15, 1921, pp. 415–418, 20 figs. partly on 3 supp. plates, and 445–449, 18 figs. Procedure at works of Ransome & Marles Bearing Co., England.

BEARINGS, ROLLER

Manufacture. Maintaining Continuity Throughout Roller Bearing Manufacture, J. Edward Schipper. Automotive Industries, vol. 44, no. 17, April 28, 1921, pp. 912–917, 22 figs. Methods used at plant of Timken Roller Bearing Co., Canton, Ohio.

N.K.A. A New Disk Type Bearing. Automotive Industries, vol. 44, no. 19, May 12, 1921, p. 996, 2 figs. N.K.A. Swedish disk. Disks are not cylindrical but are central sections of ellipsoid of revolution. Bearing comprises two race rings provided with grooves in which disks run.

BLAST-FURNACE GAS

Cleaning. Notes on the Cleaning of Blast-Furnace Gas, S. H. Fowles. Engineering, vol. 111, no. 2889, May 13, 1921, pp. 600–602, 7 figs. Methods of operating Halberg-Beth dry gas cleaning plant. (Abstract.) Paper read before Iron & Steel Inst.

BLAST FURNACES

Charging. Husson Incline System of Charging Materials Into Blast Furnaces (Monte-charge incliné système "Husson" pour haut-fourneau), M. H. Barral. Revue de Métallurgie, vol. 18, no. 2, Feb. 1921, pp. 92–95, 9 figs. Modification of Staehler system.

Design. Stack Changes Effect Economy, H. R. Stuyvesant. Iron Trade Rev., vol. 68, no. 19, May 12, 1921, pp. 1312–1313 and 1316, 3 figs. Improvements in cooling equipment, lines and hearth of Alabama blast furnace, together with introduction of casting machine and new trestle.

BLOWING ENGINES

Gas-Driven. 13 H.P. Gas-Driven Blowing Engine. Engr., vol. 131, no. 3409, April 29, 1921, pp. 451–454, 4 figs. partly on supp. plate. Engines manufactured at Galloway Works, Manchester, England.

BLUEPRINTING

Machines. Recent Progress in Blue Printing. Sci. Am., vol. 124, no. 20, May 14, 1921, p. 389, 1 fig. Machines that print, wash and dry blueprints in continuous operation.

BOILER FEEDWATER

Analyses. The Interpretation of Boiler-Water Analyses, J. R. McDermet. Mech. Eng., vol. 43, no. 5, May 1921, pp. 319–320 and 342. Limitations and applications of technical or mineral analysis. Use of partial sanitary analysis as forecasting possible trouble due to pollution. Significance of analysis for dissolved gases in relation to conditions under which it is used.

BOILER FIRING

Pulverized Coal. Economical Firing of Steel Plant Boilers, Charles Longenecker. Blast Furnace & Steel Plant, vol. 9, no. 5, May 1921, pp. 308–310 and 336. Comparison of hand-fired, stoker-fired and pulverized-coal-fired boilers. Test run on 520-hp. boiler fired by pulverized coal.

BOILER INSPECTION

Canada. Rules Governing the Inspection of Railway Stationary Boilers in Canada. Boiler Maker, vol. 21, no. 5, May 1921, pp. 137–138. Rules of Board of Railway Commissioners for Canada.

BOILER OPERATION

Losses. The Cost of Boiler Scale, W. F. Schaphorst. Ry. Mech. Engr., vol. 95, no. 5, May 1921, pp. 292, 1 fig. Chart for determining loss due to scale.

BOILERS

Electrically Heated. The Revel Electric Boiler (La chaudiere électrique revel). Industrie Electrique, vol. 30, no. 691, April 10, 1921, pp. 127–138, 3 figs. Pressure is automatically controlled by regulating surface of electrodes in contact with water.

The Utilization of Hydraulic Energy in the Electrification of Boilers (L'utilisation intégrale des forces hydrauliques par l'lectrification des chaudières), P. Bergeon. Revue générale de l'Électricité, vol. 9, no. 17, April 23, 1921, pp. 561–567, 6 figs. Economical advantages of operating boilers by electricity.

Settings. Constructing Horizontal Boiler Settings, H. E. Dart. Boiler Maker, vol. 21, no. 5, May 1921, pp. 127–131, 5 figs. Typical setting designs adopted as standard by Hartford Steam Boiler Inspection and Insurance Co.

Single-Sheet. The Single-Sheet Lap-Seam Boiler, J. P. Morrison. Power, vol. 53, no. 17, April 26, 1921, pp. 652–655, 8 figs. Weaknesses in reliability of single-sheet, lap-seam boiler are pointed out by reference to numerous explosions.

BOILERS, WATER TUBE

Stirling. Development of the Stirling Boiler. Power, vol. 53, no. 16, April 19, 1921, pp. 632–634, 7 figs. Recent modifications making for standardization of classes, greater accessibility, elimination of priming and improved setting.

Seven Recent Changes in the Stirling Boiler. Coal Age, vol. 19, no. 18, May 5, 1921, pp. 822–823, 3 figs. Front and rear steam drums raised, latter being protected by baffle. Steam now taken from rear drum. Superheater chamber enlarged. Bonding tile used front wall. Present standardization has reduced number of types from 14 to 3.

Tests. Boiler Tests with Pulverized Illinois Coal, Henry Kreisinger and John Blizard. Mech. Eng., vol. 43, no. 5, May 1921, pp. 321–322 and 326, 2 figs. Tests of 468-hp. water-tube boiler fired with pulverized Illinois coal. Results showed that, contrary to customary specification, it is not necessary to pulverize coal to extreme fineness of 85 per cent through 200-mesh screen. Best results were obtained when coal was burned at rates from 0.5 lb. to 2 lb. per cu. ft. of combustion space per hour.

BORING HEADS

Modern Types. Modern Hollow Boring and Cutter Heads (Einige neuere Hohlbohr- und Messerköpfe), Valentin Litz. Werkstattstechnik, vol. 15, no. 7, Apr. 1, 1921, pp. 177–179, 32 figs. Details of various types used during and before war for boring out guns, shafts, rods, pipes, etc.

BORING MACHINES

Herbert. A New System of Precision Boring. Eng. Production, vol. 2, no. 30, April 28, 1921, pp. 553–554, 2 figs. Boring machine manufactured by Alfred Herbert, Coventry, England, and designed for rapid machining of jigs and fixtures.

BRAKING

Heating of Wheel Tires. The Heating of Railway Wheels in Consequence of Braking (L'échauffement des bandages des roues de véhicules de chemins de fer par suite du freinage), R. Zehnder-Spörry. Bulletin technique de la Suisse romande, vol. 47, no. 9, April 30, 1921, pp. 97–102, 6 figs. Calculation of heat liberated by friction produced by braking.

BRAZING

See AIRCRAFT CONSTRUCTION MATERIALS, Brazing.

BROACHING

Keyways. Guide Bushings for Keyway Broaching. Machy. (Lond.), vol. 18, no. 447, April 21, 1921 pp. 75–76, 3 figs. Formulas for designing bushings for broaching accurate keyways.

Typical Operations. Broaching as a Production Factor, J. H. Moore. Can. Machy., vol. 25, no. 16, April 21, 1921, pp. 33–37, 10 figs. Typical broaching operations.

BRONZES

Tempering. Tempering of Tin Bronzes (Sur la trempe des laitons à l'étain) M. Léon Guillet. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 17, April 25, 1921, pp. 1038–1041, 2 figs. Effect of tempering on mechanical properties. Experiments on various types of tin bronzes.

BUILDING CONSTRUCTION

Concrete. Putting Up a Concrete Building Under Severe Difficulties, H. C. Paddock. Contract Rec., vol. 35, no. 16, April 20, 1921, pp. 383–385, 7 figs. Fish-freezing plant on island of St. Pierre erected on rocky site. Materials and labor imported. Fire of extreme severity destroyed concrete and necessitated partial rebuilding.

C

CAR DUMPERS

Tilting Unloader. A Rapid Tilting Cradle Unloader for Box Cars. Ry. Age, vol. 70, no. 16, April 22, 1921, pp. 999–1000, 2 figs. Design developed by Ottumwa Box Car Loader Co., Iowa.

CAR WHEELS

Tire-Fixing Rolls. Tire Fixing Rolls for Railway Wheels. Engr., vol. 131, no. 3408, April 22, 1921, pp. 441, 3 figs. Hydraulic press manufactured by B. & S. Massey, Openshaw, Manchester.

CARBURETORS

Atmos. An Interesting Carburetter. Automobile Eng., vol. 11, no. 150, May 1921, pp. 178–179, 3 figs. Atmos carburetors. Throttle is only moving part and forms the center portion of the venturi tube. Situated at right angles to the main venturi is an auxiliary venturi, at throat of which jet is placed with its controlling needle.

German Oekonom. The "Oekonom" Carbureto (Der Kraftstoffvernebler "Oekonom"), Wa. Ostwald. Allgemeine Automobil-Zeitung, vol. 22, no. 7, Feb. 12, 1921, pp. 28–29, 3 figs. Consists of aluminum casing provided with two glass windows, from which condition of mixture can be observed, and no fuel can leave apparatus which is not thoroughly vaporized.

Jet Calibration. Calibrating Carbureter Jets in Quantity by Actual Flow Measurement, J. Edward Schipper. Automotive Industries, vol. 44, no. 18, May 5, 1921, pp. 958–959, 3 figs. Apparatus used by Zenith Carburetor Co. consists of tank with constant head, device for holding jet, electrically controlled timing elements, and graduates for measuring volume of flow in unit time. Each operator can test 160 jets per hour by use of one calibrating machine.

Research. Experimental Research on the Best Proportion of Fuel and Air for Explosive Motors (Recherches expérimentales sur les valeurs du titre, en essence, du mélange d'alimentation des moteurs a explosion), J. Boudet. Arts et Métiers, no. 3, Dec. 1920, pp. 49–54, 7 figs. Comparative study of various types of carburetors.

CARS

Steel. Progress in the Development of the All-Steel Car, J. J. Tatum, Ry. Rev., vol. 68, no. 19, May 7, 1921, pp. 699–700. Advisability of using copper bearing steel for improving performance from standpoint of service and maintenance. Paper read before Can. Ry. Club.

CARS, COAL

100-Ton. New Norfolk & Western 100-Ton Coal Cars, John A. Pilcher. Ry. Mech. Engr., vol. 95, no. 5, May 1921, pp. 293–298, 9 figs. Body supported on side bearings instead of center plate. New type six-wheel truck.

120-Ton. The 120-Ton Coal Cars of the Virginian Railroad. Ry. & Locomotive Eng., vol. 34, no. 5, May 1921, pp. 121–124, 5 figs. Cars carried on six-wheeled trucks.

CARS, FREIGHT

Draft-Gear Tests. Draft Gear Tests of the Railroad Administration. Ry. Mech. Engr., vol. 95, no. 5, May 1921, pp. 301–304, 1 fig. Results from gears after three years' service; destructive tests and rivet-shearing tests.

High-Capacity. Real Operating Economy in the use of High-Capacity Cars. Ry. Rev., vol. 68, no. 17, April 23, 1921, pp. 629–635, 9 figs. Net revenue tonnage of freight train increased 20 per cent where 100-ton cars are used on Norfolk & Western Ry.

Reinforced-Concrete. Reinforced-Concrete Freight Cars (Eisenbahnwagenkasten aus Eisenbeton), Max Gensbaur. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 17, Apr. 23, 1921, pp. 445–446, 3 figs. States that use of such cars is shown to be technically and economically feasible; reinforced-concrete ore cars with bottom discharge do not increase weight as compared with steel trucks; a special hardening of inside surface of concrete superstructure is not necessary.

Steel. Repairs or Maintenance of Steel Freight Cars, S. Lynn. Can. Ry. Club, vol. 20, no. 3, Mar. 8, 1921, pp. 24–32. Outline of practice, with notes on experience of Pittsburgh and Lake Erie Railroad.

CARS, REFRIGERATOR

Design. A System of Transit Refrigeration and Heating, Lewis Penwell. A.S.R.E. Jl., vol. 7, no. 2, Sept. 1920, pp. 140–150, 2 figs. Equipment for refrigerating railway cars.

CAST IRON

Research. The Co-Operation of Scientific and Industrial Research in the Iron Foundry—II, Thos. Vickers. Foundry Trade Jl., vol. 23, no. 242, April 7, 1921, pp. 316–319. Scope of British Cast Iron Research Assn. (Concluded.)

CASTINGS

Blowers. Rigging for Speed in Blower Work, Herbert R. Simonds. Foundry, vol. 49, no. 9, May 1, 1921, pp. 359–363, 8 figs. Castings for forced-draft blower manufactured by Coppus Eng. & Equipment Co., Worcester, Mass.

Cracks. Annular Cracks, R. R. Clarke. Metal Industry (N.Y.), vol. 19, no. 5, May 1921, pp. 193–194, 10 figs. Discussion of various theories accounting for their formation.

Grain. The Development of Grain and Its Importance for Foundry Practice (Der Gefügeaufbau und seine Bedeutung für den Giessereibetrieb), H. Czochralski. Giesserei-Zeitung, vol. 18, nos. 6 and 7, Mar. 15 and Apr. 1, 1921, pp. 85–90 and 103–109, 30 figs. Discusses rules governing growth of crystals, speed of crystallization, etc. Illustrations and photomicrographs of idiomorphic and xenomorphic crystals, dendritic crystal formations, etc.

Non-Ferrous. Non-Ferrous Castings in Spinning Molds, Louis J. Josten. Iron Age, vol. 107, no. 20, May 19, 1921, pp. 1289–1292, 4 figs. Casting of non-ferrous bands by centrifugal casting machine at works of George C. Clark Metal Products Co., Detroit.

CEMENT, PORTLAND

Specifications. Portland Cement, R. E. Stradling. Concrete, vol. 16, no. 4, April 1921, pp. 223–233, 10 figs. Comparison of British, American, French and German specifications and methods of testing. (Concluded.)

Testing. Judging the Quality of Portland Cement, R. J. Colony. Eng. World, vol. 18, no. 5, May 1921, pp. 331–334, 8 figs. Triangular concentration diagram constructed from results obtained in anal-

yses made in laboratory of Board of Water Supply of the City of New York. Paper read before Am. Inst. Min. and Metallurgical Engrs.

CENTRAL STATIONS

Power Zones. Economic Generation of Electricity by Power Zones, H. H. Kuhn. Elec. Rev., (Chicago) vol. 78, no. 18, April 30, 1921, pp. 683–687, 2 figs. Suggests scheme for concentration of electrical generating equipment at centers of naturally divided districts with facilities for fuel or water-power production and transmission at minimum cost. Chart for determining centralized service rates.

Superpower Zones. Legal and Financial Aspects of Superpower Plan. Elec. World, vol. 77, no. 21, May 21, 1921, pp. 1153–1156, 3 figs. Discussion at meeting of Superpower Survey in New York on May 13. Preliminary to completing report on proposed establishment of superpower zone in North-eastern United States.

CHAINS

Manufacture. The Manufacture of Driving Chains. Eng. Production, vol. 2, no. 32, May 12, 1921, pp. 603–610, 22 figs. Procedure at works of Hans Renold, England.

CHRONOMETERS

Developments. Latest Developments in Chronometry (Les derniers progrès de la chronométrie), Léopold Reverchon. Nature (Paris), no. 2450, Mar. 19, 1921, pp. 177–181, 10 figs. Guillaume balancing wheel for marine chronometer.

CHUCKS

Magnetic. Magnetic Chucks—VI, Ellsworth Sheldon. Am. Mach., vol. 54, nos. 18 and 19, May 5 and 12, 1921, pp. 787–789, 11 figs., and 819–823, 13 figs. Description of Heald multiple magnet chuck.

COAL

Analysis. The Analysis of Coal, S. Roy Illingworth. Colliery Guardian, vol. 121, no. 3146, April 15, 1921, pp. 1094–1095, 4 figs. Determination of proximate analysis of coal. From book by same writer soon to be published by Colliery Guardian Co.

Briquetting. Factors to be Borne in Mind in Making Briquets of Fine Materials, J. E. Stevens. Coal Age, vol. 19, no. 15, April 14, 1921, pp. 663–666, 5 figs. Methods of briquetting coal and peat.

Salvage. Concentrating Tables Turn Incombustible Sludge from Pond Into Good Fuel, William Strain. Coal Age, vol. 19, no. 17, April 28, 1921, pp. 741–743, 5 figs. Elevator and sluice broke up lumps of clay and coal enabling concentrating tables to remove two-thirds of ash. Installation of Renton Coal Co., Renton, Washington.

Sulphur in, Analysis. The Analysis of Sulphur Forms in Coal, Alfred R. Powell. U. S. Dept. of Interior, Bur. of Mines, technical paper 254, 1921, 21 pp., 1 fig. The applicability of method of Powell and Parr to various kinds of coal. Method was found to give correct and accurate results for analysis of sulphur forms in coal.

COAL BREAKERS

Design. Preparation Methods Susquehanna Has Built Into Reconstructed Pennsylvania Breaker. Coal Age, vol. 19, no. 14, April 7, 1921, pp. 618–622, 4 figs. Jigs are placed stepped down like stairway, using single chute for feed and another for discharge. "Rock" from jigs is screened and hand-picked for clean coal of size just washed, undersize going to condemned-coal conveyor for retreatment.

Single Roll Crusher is Well Safeguarded Against Breakage by Tramp Iron. Coal Age, vol. 19, no. 14, April 7, 1921, pp. 623–624, 3 figs. Four rods opposing helical springs hold frame together. For fine crushing reversible wearing strip is provided in lower portion of breaker. Shear pin made small enough to be safely constructed of mild steel.

COAL DUST

Hazards. Coal-Dust Hazards in Industrial Plants, L. D. Tracy. U. S. Dept. of Interior, Bur. of Mines, Reports of Investigations, no. 2243, 6 pp. 1 fig. Recommendations in regard to methods of handling pulverized coal with a view to preventing dust explosions.

COAL HANDLING

Mines. At Plumville Coal is Dumped in Mine and Carried by Apron Conveyor to Tipple, Donald J. Baker. Coal Age, vol. 19, no. 16, April 21, 1921, pp. 699–703, 9 figs. Refuse from picking table is conveyed to separate rock house. Generators supplying power to mines are driven by natural-gas engines which are found cheaper than steam-driven machines.

Piers. Export Coal Facilities at the Curtis Bay, Md., Terminals of the Baltimore & Ohio Railroad, P. G. Lang, Jr. Gen. Elec. Rev., vol. 24, no. 5, May 1921, pp. 433–435, 5 figs. Electrically operated coal trimmers installed at coal-loading pier.

Rotary Shovel. Rotary Shovel That Clears Wide Path but Delivers to Fixed Point of Discharge, S. H. Hunt. Coal Age, vol. 19, no. 18, May 5, 1921, pp. 789–791, 5 figs. Loading machines developed by Milwaukee Coke & Gas Co. Rotary motion is utilized in delivering material to mine car.

COAL WASHING

Methods. Method of Washing Coal for Metallurgical Coke at Risco, in Birmingham Field, E. P. Stewart. Coal Age, vol. 19, no. 18, May 5, 1921, pp. 807–810, 5 figs. Coal crushed to 1 in. and under, jigged and delivered at steel plant with only 6 per cent moisture without use of drainage tanks or centrifugal driers. Water clarified for reuse contains only 0.15 per cent solids.

Washing Coal With Air Instead of With Water, L. E. Woods. Coal Age, vol. 19, no. 18, May 5, 1921, pp. 810–812, 4 figs. Air forced upward through table deck and its load of material almost immediately, separates light from heavy particles. Machine has large capacity and product is dry.

COKE

Nomenclature. Report of Committee D-6 on Coke. Am. Soc. for Testing Matls., advance paper, 4 pp. Proposed tentative definitions of terms related to coke.

COKE HANDLING

Plants. Coke Handling System at Lawrence, Mass., H. B. Mosley. Am. Gas Jl., vol. 114, no. 20, May 14, 1921, pp. 421–422 and 433, 6 figs. Plants for handling, sizing and storing coke.

COKE OVENS

By-Product. By-product Coke Plant of the Jones & Laughlin Steel Co., C. R. Meissner. Chem. & Metallurgical Eng., vol. 24, no. 20, May 18, 1921, pp. 891–894, 7 figs. Description of installation and operation of standard Koppers coke-oven plant at Hazelwood, Pa., capable of coking under normal conditions 5000 tons of coal per day.

COMBUSTION

Composition of Gases. Theoretical Considerations on the Composition of Combustion Gases and Gasification of Carbon (Considérations theoriques au sujet de la composition des gaz de combustion et gazéification du carbone), M. J. Seigle. Revue de Métallurgie, vol. 18, no. 2, Feb. 1921, pp. 81–91, 3 figs. Equations establishing proportions of elementary constituents in gases from boilers, blast furnaces, etc.

Control. The Scientific Control of Combustion, H. T. Ringrose. Engineering, vol. 111, no. 2888, May 6, 1921, pp. 565–566, 4 figs. CO_2 recorder consisting of porous pot inside which is placed paper cartridge containing granules of soda lime. Unit is placed inside testing box into which can be put varying quantities of carbon dioxide from gas cylinder, and tube is coupled up in connection with inside of pot to manometer. Vacuum produced is registered by manometer.

COMPRESSED AIR

Explosions in Lines. Explosions in Compressed-Air Lines, E. D. Gardner. Iron Age, vol. 107, no. 20, May 19, 1921, pp. 1293–1294. Rupture of pipe in Arizona copper mine. Explosions sometimes due to carbonized cylinder oils. Cylinder temperature large factor.

Losses in Pipes. Pressure Losses in Compressed Air Piping. Compressed Air Mag., vol. 26, no. 5, May 1921, pp. 10092. Comparative study with genuine and substitute packing materials made in German coal mine.

Mines. The Production and Transmission of Compressed Air in Mines, John T. Pringle. Trans. of North of England Inst. of Min. & Mech. Engrs., vol. 71, part 2, Feb. 1921, pp. 24–39 and (discussion) pp. 39–42, 9 figs. Also in Trans.Inst.Min.Engrs., vol. 60, pt. 2, Jan. 1921, pp. 146–151 and (discussion) 151–164, 9 figs. Requirements of compressors. Performance of Ingersoll type.

Pneumatic Tubes. Pneumatic Transmission of Messages on Warships. Engineering, vol. 111, no. 2888, May 6, 1921, pp. 548–549, 10 figs. Apparatus for pneumatic transmission of messages, constructed by T. Cooke & Sons, York, England.

CONCRETE

Alkali Action on. Engineering Investigations, E. C. Bebb. U. S. Dept. of Int. Reclamation Rec., vol. 12, no. 5, May 1921, pp. 224–227, 3 figs. Progress in investigation of alkali action on concrete.

The Effect of Alkali Upon Concrete, S. H. McCrory. Public Works, vol. 50, no. 19, May 7, 1921, pp. 390–392, 1 fig. No method known of preventing such deterioration, but impermeability retards it.

Developments. Recent Developments in Concrete. Monthly Bul. Can. Inst. Min. & Metallurgy, no. 109, May 1921, pp. 410–437, 16 figs. Survey of recent researches at representative institutions.

Proportioning Aggregates. A Logical Scheme for Determining the Concrete Making Value of Available Aggregates and Its Practical Application to the Production of Concrete of Pre-Determined Quality in the Field, G. M. Williams. Jl. Eng. Inst. of Canada, vol. 4, no. 5, May 1921, pp. 301–308, 6 figs. Investigation of current theories of proportioning concrete, and account of field tests.

CONCRETE, REINFORCED

Austrian Regulations. New Regulations for Reinforced Concrete in Austria (Neue Eisenbetonvorschriften in Oesterreich), Karl Haberkalt. Schweizerische Bauzeitung, vol. 77, nos. 13 and 14, Mar. 26 and Apr. 2, 1921, pp. 145–146 and 157–159, 2 figs. Includes table with new regulations giving permissible concrete stresses in kg. per sq. cm. Change from former regulations issued in 1911 by Bureau of Public Buildings was made in view of the shortage of building material due to changed conditions brought about by the war.

CONNECTING RODS

Manufacture. Making Motor-Car Engine Connecting Rods. Machy. (Lond.), vol. 18, no. 447, April 21, 1921, pp. 65–69, 11 figs. Machines and fixtures used for drilling, boring, milling, grinding, reaming and gaging operations.

CONVEYORS

Overhead. Overhead Conveyor System Solves Conveying Problem, F. N. Marcellus. Can. Manufacturer, vol. 41, no. 5, May 1921, pp. 45–47, 4 figs. System at works of London Machy. Co., Guelph, Canada.

Progressive Assembly. Progressive Assembly Conveyors, C. W. Starker. Machy. (N. Y.), vol. 27, no. 9, May 1921, pp. 831–832. Advantages of system in which products being assembled are conveyed past assembler.

COOLING TOWERS

Types. Water Cooling Towers—II, I. V. Robinson. Beama, vol. 8, no. 4, April 1921, pp. 346–353, 4 figs. Comparative study of different types.

COPPER

Separation from Nickel. The Separation of Copper from Nickel (Trennung des Kupfers von Nickel). Elektrochemische Zeit., vol. 27, no. 7, Jan. 1921, pp. 61–63. Process devised by Hybinette (Christiania) according to which an anode containing alloy of copper and nickel is electrolyzed in a solution of nickel sulphate and a weak acid.

COPPER ALLOYS

Copper-Zinc. The Specific Heat of Copper-Zinc Alloys at High Temperatures (Ueber die spezifische Wärme technischer Cu-Zn-Liegierungen bei höheren Temperaturen), Fr. Doerinckel and Max Werner. Zeit. für anorganische u. allgemeine Chemie, vol. 115, no. 1–2, Jan. 14, 1921, pp. 1–48, 16 figs. Specific heat of technically important copper-zinc alloys was determined according to mixture method.

Heat Treatment. Heat Treatment of Copper Alloys, J. S. Glen Primrose. Metal Industry (Lond.), vol. 18, no. 15, April 15, 1921, pp. 281–286, 6 figs. Effect of heat treatment upon finer properties. Paper read before Instn. British Foundrymen.

COLD STORAGE

Plant Design. Antwerp's Government Cold Stores. Cold Storage, vol. 24, no. 277, April 21, 1921, pp. 97–99, 3 figs. Refrigeration is effected by mixed system of direct expansion through pipes suspended from ceiling and ventilation from two powerful air-circulating batteries.

CORK

Artificial. The Most Recent Processes for the Production of Artificial Cork (Die nuesten Verfahren zur Herstellung von künstlichem Kork), S. Halen. Kunststoffe, vol. 10, no. 24, Dec. 11, 1920, pp. 219–220. Foreign and domestic patented processes.

COST ACCOUNTING

Machine-Tool Industry. Cost Accounting for the Machine Tool Builder. Am. Mach., vol. 54, no. 17, April 28, 1921, pp. 726–731, 1 fig. Report of Scovell, Wellington & Co. to National Machine Tool Builders' Assn.

Overhead. When Machines are Idle. Factory, vol. 26, no. 8, April 15, 1921, pp. 947–952, 2 figs. Consideration of overhead cost in dull periods. Opinions expressed by manufacturers and industrial engineers.

COSTS

Industrial. A Comparison of Pre-War and Post-War Production Costs in Engineering, R. J. A. Pearson. Engineering, vol. 111, no. 2887, April 29, 1921, pp. 537–540. Application of mathematical methods to investigate financial and industrial situations. Paper read before Royal Statistical Soc.

COUPLINGS

Flexible. The Flexible Couplings of the German General Electric Co. (Die AEG-Streifenkupplung), L. Hultzsch. Der praktische Maschinen-Konstrukteur, vol. 53, no. 51, Dec. 23, 1920, pp. 438–439, 4 figs. Patented flexible coupling employing leather belts and adapted to both constant and alternating direction of rotation.

COUPLINGS, CAR

Automatic. The Boonzaier Automatic Coupling. Model Engr. & Elecn., vol. 44, no. 1042, April 14, 1921, pp. 290–291, 2 figs. Combination hook and link secured by means of fork or bracket to existing drawgear. Action of coupling is performed by one coupling member overriding other on contact.

CRANES

Traveling. Designing Traveling Cranes with Regard for Safe Operation, Nicolaas Prakken. Am. Mach., vol. 54, no. 18, May 5, 1921, pp. 761–765, 10 figs. Typical safety appliances.

CUPOLAS

Design. Design of Cupola and Accessory Areas, Y. A. Dyer. Iron Age, vol. 107, no. 20, May 19, 1921 pp. 1313–1314 and 1347–1348, 1 fig. Ratios of tuyère to cupola and blast-pipe area; bustle pipe to blast pipe and tuyère areas. Height related to economic conditions.

Slag, Formation. Slag in Cupolas (Die Schlacken im Kupolofen), H. Kalpers. Zeit. für die gesamte Giessereipraxis, vol. 42, no. 15, Apr. 9, 1921, pp. 201–202. Deals with conditions causing slag formation and possibilities of combating them.

Supplementary Oil Firing. Recent Tests with Oil Addition in the Firing of Cupolas (Neuere Versuche mit Oelzusatzfeuerung für Kuppelofenbetrieb), Karl K. Berthold. Stahl u. Eisen, vol. 41, no 12, Mar. 24, 1921, pp. 393–399, 1 fig. Account of tests, carried out in view of the coke shortage in Austria. It was possible to reduce the coke charge to extent of 4 to 5 kg. with an oil consumption of 1 kg. for each 100 kg. of charged iron. The hourly melting capacity was increased 30 to 50 per cent, the temperatures of iron fulfilled the highest requirements, and the so greatly feared enrichment with sulphur was con-

siderably reduced. Address before Austrian section of Assn. German Engrs., Vienna.

CUTTING TOOLS

Cutting Speeds. Cutting Speeds for Steel and Cast-Iron. Belting, vol. 18, no. 4, April 1921, pp. 72. Tables showing cutting speeds.

Diamond. The Diamond as a Cutting Tool. Eng. Production, vol. 2, no. 29, April 21, 1921, pp. 521–523, 10 figs. Its application in production work.

D

DIE CASTING

Methods. Die-Casting Methods and Metals—II and III, M. H. Potter. Foundry, vol. 49, nos. 9 and 10, May 1 and 15, 1921, pp. 342–344, 2 figs., and 404–406, 4 figs. Data regarding various metals and alloys which may be die cast are given and comparison is made between results from casting in sand and in dies. Methods of placing inserts in die castings. Details of cleaning baths and electroplating process.

DIE SINKING

Machine for. New Design of Die-Sinking Machine. Machy. (N.Y.), vol. 27, no. 9, May 1921, pp. 843–844, 6 figs. Machine brought our by Billings & Spencer Co., Hartford, Conn. Some of features are wide range of work, adaptability both to low and high cutter speeds, and method of holding and clamping shanks of cutters.

DIES

Conical Parts. Dies for Producing A Conical Part Machy (Lond.), vol. 18, no. 447, April 21, 1921, pp. 78–81, 14 figs. Operations in manufacturing difficult shell.

DIESEL ENGINES

Fuel Injection. Devices for Injection of Fuel Oil with Use of Injection Air in Diesel Engines without Regulation of the Discharge Openings (Vorrichungen zum Einspritzen von Brennöl unter Ver wendung von Einblaseluft ohn Regelung der Ausspritz-Querschnitte), F. E. Bielefeld. Oel- u. Gasmascine, vol. 18, no. 3, Mar. 1921, pp. 37–39, 3 figs. Describes fuel-injection devices patented by author.

German Submarines. The German Submarine Diesel Engine, Holbrook C. Gibson. Jl. Soc. Automotive Engrs., vol. 8, no. 5, May 1921, pp. 410–415, 10 figs. Engines were in majority of cases of Maschinenfabrik-Ausburg Nürnburg, four-cycle reversible type.

Manufacture. The First True Diesel Made in Canada. Mar. Eng., vol. 11, no. 4, April 1921, pp. 17–20, 6 figs. Manufacturing processes at works of Dominion Steel Products Co.

Marine. The Sulzer Marine Diesel Engines. Practical Engr., vol. 63, no. 1782, April 21, 1921, pp. 244–247, 3 figs. Efficiency curves of two-cycle and four-cycle engines.

Standard. Standard Fuel-Oil Vertical Two-Stroke-Cycle Diesel Engine. Power, vol. 53, no. 17, April 26, 1921, pp. 656–658, 7 figs. Engine manufactured by Standard Fuel Oil Engine Co., Bucyrus, Ohio, in sizes from 50 to 200 hp.

Standardized. Standardized Diesel Engines—III. H. R. Setz. Mar. Eng., vol. 26, no. 5, May 1921, pp. 391–392, 1 fig. Description of valve-in-head method of scavenging for two-cycle type engine.

DRILLS

Breast. The Manufacture of a Breast Drill. Machy. (Lond.), vol. 18, no. 448, April 28, 1921, pp. 97–101, 11 figs. Practice of J. W. Bradley Small Tools Co., Leicester, England, in production of breast drills of single and two-speed types.

DROP FORGINGS

Heat Treatment. The Heat Treatment of Drop Forgings, Leslie Aitchison. Forging & Heat Treating, vol. 7, no. 5, May 1921, pp. 255–264, 6 figs. Influence of alloying elements on hardening. Mechanical effects of heat treatment.

Steel Castings vs. Drop Forgings Replace Steel Castings, F. B. Fairbanks. Forging & Heat Treating, vol. 7, no. 4, April 1921, pp. 214–215, 3 figs. Claims forgings provide product of superior strength, toughness and resistance to shock and wear at lower cost.

DUST

Precipitation. Laying the Dust With Fog, Donovan McClure. Sci. Am. Monthly, vol. 3, no. 5, May 1921, pp. 419–420, 6 figs. Device for producing mist artificially.

E

EDUCATION, INDUSTRIAL

Employees. Today's Labor Problems, Charles Piez. Factory, vol. 26, no. 9, May 1, 1921, pp. 1059–1061. Urges instructing employees on subjects of wages, output, employer's profits, sympathetic strikes, and other questions about which they now have false notions.

ELECTRIC DRIVE

Steel Mills. The Steel-Mill Frequency Problem, B. G. Lamme. Elec. World, vol. 77, no. 17, April 23, 1921, pp. 921–923, 1 fig. Six general methods are pointed out for economically using 60-cycle purchased energy in plant with 25-cycle equipment.

ELECTRIC FURNACES

Electrode Economizers. Economizer Reduces Heat Dissipation, Frank Hodson. Iron Trade Rev., vol. 68, no. 17, April 28, 1921, pp. 1180–1181, 2 figs. Type of cooling ring or electrode economizer manufactured by Elec. Furnace Construction Co., Phila. Discussion presented at meeting of Am. Electrochemical Soc.

Foundries. Acid vs. Basic Electric Furnace for the Foundry, F. W. Brooke. Chem. & Metallurgical Eng., vol. 24, no. 18, May 4, 1921, p. 794. Uses to which each type is best suited.

Indirect Arc. A New Indirect Arc Furnace. Metal Industry (N. Y.), vol. 19, no. 5, May 1921, pp. 191–192, 2 figs. Three-phase gyrating electric furnace built by Volta Mfg. Co., Ontario.

Induction-Vacuum. The Influence of Gases on Metals (Gassers indvirkning paa metaller), Sigurd Hiorth Teknisk Ukeblad, vol. 68, nos. 7 and 8 Feb. 18 and 25, 1921, pp. 77–79 and 85–89, 6 figs. It is claimed that electric induction furnaces are excellently adapted to melting and heat-treating in vacuum. Notes on capacity of metals in molten state to absorb gases and retain them after congealing. Review of former works and experiments and brief account of author's work with the induction-vacuum furnace; process is said to be simple and inexpensive.

Smothered-Arc. Electric Furnaces for Melting Non-Ferrous Metals. Chem. & Metallurgical Eng. vol. 24, no. 18, May 4, 1921, p. 793, 1 fig. Typ. recently brought out by Gen. Elec. Co.

Smothered Arc for Nonferrous Furnaces. Foundry, vol. 49, no. 9, May 1, 1921, pp. 363–364, 2 figs. Electric furnaces developed by Gen. Elec. Co.

Steel Manufacture. Electric Furnaces for Making Steel—III, Alfred Stansfield. Blast Furnace & Steel Plant, vol. 9, no. 5, May 1921, pp. 324–327, 3 figs. Classification of electric steel-making furnaces. General features and advantages of arc furnace and resistance furnace. Operating features of electric furnaces.

ELECTRIC LAMPS, ARC

New Type. A New Type of Arc Lamp (Eine neuartige Bogenlampe), Albert Bencke. Elektrotechnischer Anzeiger, vol. 38, no. 49–50, Mar. 30, 1921, pp. 289–290. Arc lamp invented by M. Gabaccini and accepted by French government for marine purposes.

ELECTRIC LOCOMOTIVES

Developments. Review of Recent Large Electric Locomotives, A. Laternser. Elecn. (Lond.), vol. 86, no. 2243, May 13, 1921, pp. 584–586, 6 figs. Comparative data of recent American and European electric locomotives. Translated from Schweizerische Bauzeitung.

Steam vs. Characteristics of the Electric Locomotive. Ry. Elec. Engr., vol. 12, no. 5, May 1921, pp. 195–200, 8 figs. Advantages of electric locomotive over steam locomotive. Paper read before Franklin Inst.

ELECTRIC PLANTS

Interconnection. Limitations of Interconnection. E. C. Stone Elec. World, vol. 77, no. 18, April 30, 1921, pp. 990–991. Rupturing capacity of oil switches under short-circuit conditions limits interconnection unless plants are well distributed.

Operation. Output of Nine Electric Systems in 1920, Exceeded 1,000,000,000 Kw.-Hr. Each. Elec. World, vol. 77, no. 17, April 23, 1921, pp. 924–927. Data on generated and purchased output of largest generating and distributing systems in U. S. and Canada during 1920.

ELECTRIC RAILWAYS

Braking, Regenerative. Operating Curves and Operating Safety of Different Methods of Regenerative Braking in Electric Railways (Ueber Betriebskurven und Betriebssicherheit verschiedener Verfahren der Nutsbremsung bei elektrischen Bahnen), W. Kummer. Schweizerische Bauzeitung, vol. 77, nos. 13 and 14, Mar. 26 and Apr. 2, 1921, pp. 139–142 and 151–155, 11 figs. Investigation of operating curves of motors with separate excitation, of d.c. motors with series excitation, and single-phase motors with series excitation. It is pointed out that operating safety is to a great extent dependent on the operating curves, and it is concluded that regenerative braking can only be regarded as actually safe on 3-phase current and single-phase a.c. railroads using the Oerlikon connection or the single-phase 3-phase current transformation.

ELECTRIC TRANSMISSION LINES

Design. Economical Design of a Transmission Line, Ryotaro Mitsuda. Researches of Electrotechnical Laboratory, no. 79, Sept. 1919, 212 pp., 137 figs. Equations for determining most economical voltage of transmission, size of conductors and spacing of towers.

High-Voltage. French Transmission Line for 100 Kv., M. A. Henriod. Elec. World, vol. 77, no. 18, April 30, 1921, pp. 982–985, 12 figs. Transmission of energy at 110,000 volts over 115 miles of mountains and wooded country.

220,000-Volt. 220,000-Volt Transmission Progress, John A. Koontz, Jl: Electricity & Western Industry, vol. 46, no. 10, May 15, 1921, pp. 477–479, 9 figs. Report of Engineering Sub-Committee to the Pacific Coast Division of National Electric Light Association. It is concluded from laboratory research that the most logical scheme for developing a 220,000-volt insulator "seems to be that of utilizing the present 10-in. unit . . . but providing means to properly take care of the voltage distribution throughout the string . . . when more than eight or nine units are used."

Wire Joints. Mechanical Resistance of Joints of Aerial Electric Transmission Lines (Essais de la résistance mécanique de joints de fils de lignes aériennes). Industrie Electrique, vol. 30, no. 691, April 10, 1921, pp. 125–127. Tests conducted by Administration of Swiss Telegraph.

ELECTRIC WELDING

Rails. Methods for the Electric Welding of Rails (Methoden der elektrischen Schienenschweissung), P. Max Grempe. Elektrotechnischer Anzeiger, vol. 38, nos. 36, 38 and 39, Mar. 5, 9 and 10, 1921, pp. 193–197, 211–213 and 215–217, 39 figs. Development and advantages of electric welding of rails.

ELECTRIC WELDING, ARC

Boiler Shells. The Electric Welding of a Corroded Boiler-Shell, A. Kenneth Dawson. Trans. of North of England Inst. of Min. & Mech. Engrs., vol. 71, part 1, Dec. 1920, pp. 8–12, 2 figs. Repairing corroded Lancashire boiler by use of portable electric-arc welding apparatus.

Kjellberg System. The Kjellberg Welding and Its Use in Ship Construction (Kjellbergsche Schweissung und deren Verwendung bei Schiffsneubauten), Oskar Kjellberg. Autogene Metallbearbeitung, vol. 13, nos. 23 and 24, Dec. 1 and 15, 1920, pp. 292–295 and 306–310, and vol. 14, nos. 1, 2, 4 and 5, Jan. 1, 15, Feb. 15 and Mar. 1, 1921, pp. 4–7, 27–30, 51–54 and 74–78, 35 figs. Description of author's arc welding system and report of investigations of work carried out with this process. Notes on recommendations for electrically welded pulls in the United States. Testimony of British Lloyd concerning welded ships and author's own opinion. Possibilities of repairs.

Heat Treatment of Welds. Effect of Heat Treatment on Nitride in Metal Arc Welds, James W. Owens, J. H. Ramage and J. A. Watts. Welding Engr., vol. 6, no. 4, April 1921, pp. 23–27, 16 figs. Experiments indicated that heat treatment to which deposited metal has been subjected determines form of nitride in metal, and that form in which nitride exists has very decided effect upon physical properties of metal. Paper read before Am. Welding Soc.

EMPLOYEES' REPRESENTATION

Shop Committee. Employe Representation in Management, R. L. Wilson. Textile World, vol. 49, no. 18, April 30, 1921, pp. 117–119. Shop committees organized by East Pittsburgh plant of Westinghouse Elec. & Mfg. Co.

ENGINEERING

Scholarship and Eminence in. Scholarship and Eminence in Engineering, Raymond Walter. Eng. Education, vol. 11, no. 8, April 1921, pp. 361–377. Study of scholastic training of group of eminent engineers conducted under auspices of Am. Assn. Collegiate Registrars showed "close correspondence between good scholarship in collegiate courses and professional eminence in engineering."

ENGINEERING SCHOOLS

Columbia School of Mines. The Columbia School of Mines Idea, George J. Young. Eng. & Min. Jl., vol. 111, no. 18, April 30, 1921, pp. 744–746. Six years' course established by Columbia University. First three years form basis of liberal education and last three are devoted to technical studies.

ENGINEERING SOCIETIES

Federated American Engineering Societies. The American Engineering Council, Dexter S. Kimball. Science, vol. 53, no. 1374, April 29, 1921, pp. 399–402. Purpose and aims of Federated American Engineering Societies. Address delivered before Engineers' Club of Phila.

Organization. On the Organization of an Engineering Society, Morris Llewellyn Cooke. Mech. Eng., vol. 43, no. 5, May 1921, pp. 323–325 and 356.

EXPLOSIVES

Liquid Oxygen. Liquid Oxygen Explosives. Engr., vol. 131, no. 3408, April 22, 1921, pp. 426–427. Survey of recent developments in Germany and U. S.

EXTRUSION OF METALS

Extruded and Drawn Brass Rods. Extruded and Drawn Bars (Gepresste und gezogene Stangen). Der praktische Maschinen-Konstrukteur, vol. 54, no. 17, Apr. 28, 1921, pp. 70–72, 8 figs. Details of production at the metal works of the German Genera Elec. Co.

EYEBOLTS

Strength. The Mechanical Qualities Required in Eyebolts: With Some Consideration of the Izod Test, in its Relation to the Question of Brittleness in Mild Steel, R. T. Rolfe. Jl. Instn. Mech. Engrs., no. 3, April 1921, pp. 177–189, 4 figs. partly on supp. plate. From consideration of results found in experimental investigation it is suggested that carbon content of steel should be 0.34 per cent, and Izod figure not less than 25 ft-lb.

F

FANS

Electric Drive. Motor Drive for Fans and Blowers, Gordon Fox. Power, vol. 53, no. 17, April 26, 1921, pp. 664–666, 4 figs. Rotary blowers and fans classified and described. Limitations, characteristics in operation and power requirements. Motors best adapted to different types and regulation to use for speed adjustment.

FATIGUE

Iron and Steel Works. Fatigue and Efficiency in Iron and Steel Works—VI, H. M. Vernon. Eng. & Indus. Management, vol. 5 no. 16, April 21, 1921, pp. 461–462. Investigations carried out by British Indus. Fatigue Research Board.

FIRE HOSE

Specifications. Report of Committee D-11 on Rubber Products. Am. Soc. for Testing Matls.,

advance paper, 69 pp. 3 figs Proposed tentative specifications for cotton rubber-lined fire hose for use by public fire departments.

FIRE PROTECTION

Smoke Shafts. Automatic Arrangement for the Opening of Smoke Shafts in Rooms Exposed to Fire. (Automatische Einrichtung zum Oeffnen von Abgaseschächten in feuergefährlichen Räumen), Max Becker. Feuerwehrtechnische Zeit., vol. 8, no. 23–24, Dec. 20, 1920, pp. 204–207, 3 figs. Manometric releasing device developed and patented by writer.

FLOW OF GASES

Meters. A Device for Measuring the Flow of Gases, Carle R. Hayward. Chem. & Metallurgical Eng., vol. 24, no. 18, May 4, 1921, pp. 780, 3 figs. Apparatus developed in metallurgical laboratory of Mass. Inst. of Technology.

Pipes. Flow of Gas Calculation Chart, E. T. Anderson. Gas Age, vol. 47, no. 8, April 25, 1921, p. 322, 1 fig. Chart for calculating flow of gas in pipe.

FLYING BOATS

Caproni. The Caproni Tandem Triplane. Aeronautics, vol. 20, no. 393, April 28, 1921, p. 299, 6 figs. Characteristics: Engines, 8 liberty 400 hp.; span, 100 ft.; length, 74 ft.; height, 31 ft. 6 in.; chord, 8 ft. 7 in.; gap, 8 ft. 7 in.; wing area, 7800 sq. ft.; weight empty, 30,000 lb.; speed at ground, 90 m.p.h.

The Caproni "Nineplandem" Flying Boat. Flight vol. 13, no. 17, April 28, 1921, pp. 289–291, 9 figs. Characteristics: Span, 98 ft. 6 in.; length overall, 79 ft.; chord, 9 ft. 4 in.; total wing area, 7680 sq. ft.; total weight empty, 32,800 lb.; cruising speed, 87 m.p.h.

FORGING

Drop Hammers. Air vs. Steam for Forge Shop Hammers, Chas. R. Edwards. Forging & Heat Treating, vol. 7, no. 4, April 1921, pp. 220–221 and 229, 4 figs Compressed air gives better expansion, no hot water drip, no delay in starting. Compressed air fittings must be tighter because of lower temperature. Costs about same in each case.

Cost of Operating Hammers With Air or Steam, G. H. Richey. Forging & Heat Treating, vol. 7, no. 4, April 1921, pp. 217–218. Calculations for ascertaining cost of operating hammers with compressed air and steam. Advantages of operating with air.

Spring Hammer. A New Forging Hammer (Ein neuer Bugelfeder-Hammer). Der praktische Maschinen-Konstrukteur, vol. 54, no. 14, Apr. 7, 1921, pp. 57–58, 3 figs. Describes new hammer built by Paul Rädeke, Berlin, mounted on four columns, main feature of which is the semi-circular laminated spring whose ends are attached to centrally located hammer face through links.

Swaging. Swaging Practice—III (Plaudereien aus der Gesenkschmiede), Paul Heinrich Schweissguth. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 12, Mar. 19, 1921, pp. 292–294, 48 figs. Shows how by folding and curling up finished metal articles, novel methods as to forming them from raw material may be developed. Pitchforks, carriage-top hardware and grubbing hoes used as examples of the value of method.

FORGING MACHINES

Nuts and Rivets. A Nut and Rivet Forging Machine. Eng. Production, vol. 2, no. 30, April 28, 1921, pp. 543–544, 2 figs. Design for quantity production.

FORGING PLANTS

Layout. Shop Well Planned for Material Handling, Gilbert L. Lacher. Iron Age, vol. 107, no. 18, May 5, 1921, pp. 1159–1162, 5 figs. Layout of plant of Kropp Forge Co., Cicero, Ill.

FORMING TOOLS

Straight. Dimensions of Straight Forming Tools. Machy. (Lond.), vol. 18, no. 448, April 28, 1921, pp. 103–107, 1 fig. Tables giving depth of steps on straight forming tools measured at right angles to front face, corresponding to various differences between radii on work.

FOUNDRIES

Austria. The New Foundry Plant of the Automobile Department of the Austrian Munition Works in Steyr [Das neue Gusswerk der Oesterreichischen Waffenfabriksgesellschaft (Automobilabteilung) in Steyr], Carl Irresberger. Stahl u. Eisen, vol. 41, nos. 4, 9 and 12, Jan. 27, Mar. 3 and 24, 1921, pp. 105–110, 288–293 and 401–406, 36 figs. Plans were drawn on basis of a daily production of the total requirement of gray-iron, aluminum, brass, bronze and white-iron castings for at least 60 automobiles besides a yearly production of 800 to 1000 tons of machine-tool castings in pieces weighing up to 5 tons. Plant is divided into three parts, an automobile gray-iron casting, an aluminum and brass casting, and a machine-tool casting department.

Design. Foundry Design Needs Study, J. H. Hopp. Foundry, vol. 49, no. 9, May 1, 1921, pp. 345–347. Foundry buildings should be designed with view of coördinating structure with demands of operation and protecting equipment against elements. Paper read before Am. Foundrymen's Assn.

Equipment. A Modern American Foundry. Eng. Production, vol. 2, no. 29, April 21, 1921, pp. 507–510, 4 figs. Equipment and labor saving devices at foundry of Lycoming Motors Corp., Williamsport, Pa.

Malleable-Iron. Changing Losses to Profits in a New England Casting Plant, Herbert R. Simonds. Iron Trade Rev., vol. 68, no. 18, May 5, 1921, pp. 1237–1243, 13 figs. Reconstruction and reorganization of malleable iron foundry. System for recording operations is feature.

Metal. Utilization of Scrap and Residues in Metal Foundries—I, C. Diegel. Metal Industry (N.Y.), vol. 19, no. 5, May 1921, pp. 196–197. German practice. Translated from Betrieb.

Mold-Drying Ovens. The Voith Mold-Drying Oven Fired with Low-Grade Fuels (Die Voith'sche Trockenkammerfeurung für minderwertige Brennstoffe), H. Adämmer. Stahl u. Eisen, vol. 41, no. 12, Mar. 24, 1921, pp. 399–401, 4 figs. Details of arrangement and operation of mold-drying ovens of the J. M. Voith Machine Works, Heidenheim, Germany, using good coke and also low-grade coke-lignite or coke breeze.

Navy Yard. Navy Foundry Covers Wide Range, S. W. Brinson. Foundry, vol. 49, no. 9, May 1, 1921, pp. 335–341, 11 figs. Shop at Norfolk is equipped to handle gray-iron, steel and non-ferrous castings. Handling facilities provided to care for materials.

FURNACES, ANNEALING

Electric. Electricity Applied to Annealing, George P. Mills. Foundry, vol. 49, no. 9, May 1, 1921, pp. 366–368. Pit furnaces heated electrically by means of resistance ribbon are described. Pyrometric control with either single or double-point recorder regulates temperature closely.

FURNACES, BOILER

Low-Grade-Fuel. Steam-Boiler Furnaces (Dampfkesselfeuerungen), H. Berner. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 15, Apr. 9, 1921, pp. 371–375, 8 figs. Change in requirements of furnaces due to use of low-grade fuels; combustion process and performance of low-grade fuels; the mechanical draft; change in furnace losses. Notes on horizontal and traveling grates; special furnaces for peat, wood and lignite, etc.

Rotary. Rotary Furnaces for the Economic Combustion of Coal Having Large Ash Content (Foyer rotatif pour la combustion économique des charbons très cendreux), L. Poirson. Chaleur & Industrie, vol. 2, no. 3, Mar. 1921, pp. 120–124, 6 figs. Grating is formed by inclined cylinder which is continuously rotating. Coal is burned inside cylinder.

FURNACES, HEATING

Sheet Bar vs. Mill Type. Heating Furnaces and Annealing Furnaces, W. Trinks. Blast Furnace & Steel Plant, vol. 9, no. 5, May 1921, pp. 305–308, 7 figs. Critical comparison of pair (sheet bar) and of mill type furnaces. Sheet bar furnaces are continuous.

Sheet Furnaces. Heating Furnaces and Annealing Furnaces, W. Trinks. Forging & Heat Treating, vol. 7, no. 4, April 1921, pp. 222–227, 10 figs. Comparison of different types of sheet furnaces.

FURNACES, HEAT-TREATING

Car vs. Car-and-Ball. Car and Car-and-Ball Furnaces. Machy. (N.Y.), vol. 27, no. 9, May 1921, pp. 873–875, 5 figs. Relative merits of heat-treating furnaces of car and car-and-ball types.

G

GAGES

Gage Blocks. Interference Methods for the Investigation of Gage Blocks (Interferenzmethoden zur Untersuchung von Endmassen), G. Berndt. Betrieb, vol. 3, no. 14, Apr. 10, 1921, pp. 389–396, 20 figs. Notes on origin of interferences of equal thickness and their use in investigation of smoothness of surfaces and for measurement of differences in length (methods of Bureau of Standards, of Köster, and Göpel); absolute determination of length with interferences of equal thickness; interferences of equal inclination and their use in measurement technique. Definition of length of gage blocks.

Manufacture. A Modern Jig and Tool Works. Automobile Engr., vol. 11, no. 149, April 1921, pp. 138–141, 11 figs. Manufacture of precision gages and tool making at Robinhood Eng. Works, London.

Screw-Thread. The Manufacture of British Association Screw-Thread Gauges, T. Farrance Davey. Jl. Instn. Mech. Engrs., no. 3, April 1921, pp. 191–196. Design, methods and apparatus used in measurement, compensation and correction for errors in lathe, cutting tools, lapping, and heat treatment.

GAGING

Limit. The Principles of Limit Gauging, A. A. Remington. Engineering, vol. 111, nos. 2885 and 2886, April 15 and 22, 1921, pp. 441–443, 7 figs., and 480–482, 5 figs. Attempt to build up logical system of limit gaging from first principles. Exposition of Newall standard system, extensively used in England.

GALVANIZING

Developments. 60 Years Progress in Galvanizing, Clement F. Poppleton. Iron Trade Rev., vol. 68, no. 17, April 28, 1921, pp. 1170–1174, 4 figs. Comparison of English and American processes.

GAS ENGINES

See BLOWING ENGINES, Gas-Driven.

GAS MANUFACTURE

Low-Temperature Carbonization. Low Temperature Carbonization of Coal, Steward J. Lloyd. Am. Gas Jl., vol. 114, no. 17, April 23, 1921, pp. 353–354 and pp. 363–364. Survey of recent developments.

Elliott Gas. Elliott Gas, a Substitute for Natural Gas, F. J. Denk. Forging & Heat Treating, vol. 7, no. 4, April 1921, pp. 208–212, 5 figs. Process of manufacturing combination coal and water gas from bituminous coal.

GASES

Dust Precipitators. A New Electrical Precipitation Treater, Motoji Shibusawa and Jasujiro Niwa. Researches of Electrotechnical Laboratory, no 82, Feb. 1921, 31 pp., 35 figs. Cottrell precipitator with glass-covered electrode.

GASOLINE ENGINES

Fuel Economizer. Fuel Economizer for Petrol Engines. Engineering, vol. 111, no. 2889, May 13, 1921, p. 585, 10 figs. Apparatus for reducing fuel consumption of gasoline engines which are operated for a great part of the time at less than full load. It consists of heating chamber to bring about better vaporization of fuel and air valve to dilute mixture with heated air under all conditions of partial load. Manufactured by Lancashire Ordnance Accessories Co., Stockport, England.

GEARS

Helical. New Sykes Double Helical Gear Generator. Machy. (Lond.), vol. 18, no. 450, May 12, 1921, pp. 187–190, 4 figs. Application of pinion type of generating cutter.

The Sykes Double Helical Gear Generator. Engineering, vol. 111, no. 2887, April 29, 1921, pp. 520–522, 7 figs. Cutters are retained in gearing contact with wheel being cut and rotate during process of generation. Machine manufactured by Power Plant Co., West Drayton, England.

Involute. The Evolution of the Involute Gear Tooth—IV, A. Fisher, Machy. (Lond.), vol. 18, no. 447, April 21, 1921, pp. 70–72, 1 fig. Limitations necessitated partly by requirements of interchangeability and partly by solidity of metal.

Maag. The Maag System of Gearing—II. Engr., vol. 131, no. 3407, April 15, 1921, pp. 403–404, 2 figs. Teeth of each wheel are formed on pitch circle of diminished diameter at pressure angle of 15 deg. Thereafter teeth are pushed out radially at proportionate rates until teeth of one wheel touch teeth of other at point dividing line joining shaft centers in desired gear ratio.

Quantity Production. Quantity Production in a Gear Shop—II, Fred R. Daniels. Machy. (N.Y.), vol. 27, no. 9, May 1921, pp. 863–867, 9 figs. Practice of Dittmer Gear & Mfg. Corp., Lockport, N. Y., in manufacture of gears for tractors, trucks, and automobiles.

Spur. Formulae for Measuring Spur Gears by the Pin Method, M. D. Wilson, Mach. (Lond.), vol. 18, no. 447, April 21, 1921, pp. 92–94, 4 figs.

The Shape of Spur-Wheel Teeth for Maximum Life (Die Zahnform des Stirnrades mit längster Lebensdauer), Eugen Stübler. Betrieb, vol. 3, no. 14, Apr. 10, 1921, pp. 414–420, 9 figs. Writer describes and recommends the more accurate tooth flanks. Comparison of the trochoidal and cycloidal types of toothed gearing.

GRAIN ELEVATORS

Floating. Floating Pneumatic Grain Discharging Plant. Engr., vol. 131 no. 3406, April 8, 1921, pp. 378 and 381–384, 9 figs. Combination of pneumatic and band systems for simultaneously discharging from grain ship to lighters by spouts or by means of band conveyor across deck of ship to bands below quay. Capacity is 180 tons per hour. Plant is carried on reinforced-concrete pontoon.

GRINDING

Fixtures. The Use of Special Fixtures in Grinding Operations, Ellsworth Sheldon. Am. Mach., vol. 54, no. 17, April 28, 1921, pp. 736–739, 10 figs. Cylindrical work ground on dead centers. Special holding devices for grinding chuck shells. Magnetic chucks provided with holding strips and aligning bars.

Railway Shops. Economical Grinding Operations Reduce Repair Costs, Herbert R. Simonds. Abrasive Industry, vol. 2, no. 5, May 1921, pp. 153–159, 12 figs. Repair operations at Billerica, Mass., shops of Boston & Main Railroad.

Surface Grinding. Surface Grinding 700 Ball Races Every Hour, J. H. Moore. Can. Machy., vol. 25, no. 18, May 5, 1921, pp. 65–71, 24 figs. Relation of magnetic chucks to surface grinding. Methods of grinding steel forgings, gear blanks, cylinder castings, locomotive-crankpin washers, dies, push rods and connecting rods.

GRINDING MACHINES

British Types. Substantial Design Characterizes British Grinding Machines. Abrasive Industry, vol. 2, no. 5, May 1921, pp. 174–177, 8 figs. Typical British types.

GUN METAL

Specifications. Notes on Gun-Metal, R. T. Rolfe. Metal Industry, (Lond.), vol. 18, no. 14, April 8, 1921, pp. 265–268. Comparison of British Admiralty and British Air Board specifications.

H

HANDLING MATERIALS

Factories. How Materials Are Handled at the Buda Plant, S. Gordon Hyde. Material Handling Mag., vol. 2, no. 1, Mar. 1921, pp. 10–13, 7 figs. Material-handling methods of Buda Co., Harvey, Ill., manufacturers of heavy-duty four-cylinder gasoline engines, electrical industrial trucks and tractors for factory use, railroad gasoline motor cars, etc.

Purchasing and Handling Material in a Moderate Sized Factory—I, Guy V. Sweet. Indus. Manage.

ment, vol. 41, no. 9, May 1, 1921, pp. 335–337, 5 figs. Forms for keeping records of moving material.

Foundries. Handling 168 Tons for Every Ton Produced, Max Sklovsky. Material Handling Mag., vol. 2, no. 1, Mar. 1921, pp. 5–7, 1 fig. Analysis of material-handling system of modern foundry.

Steel Products. Efficient Handling and Trucking of Steel Products, E. C. Phillips. Iron Age, vol. 107, no. 20, May 19, 1921, pp. 1294–1295. Devices speed loading and unloading of motor trucks.

HANGARS

Design. Airship Sheds and Their Erection. Flight, vol. 13, no. 15, April 14, 1921, pp. 263–264, 1 fig. Types of hangar built in Germany during war.

The Great German Dirigible Centers (Les grands centres allemands de dirigeables), J. Sabatier. Aéronautique, vol. 3, no. 22, Mar. 1921, pp. 108–112, 6 figs. Typical designs of hangar and equipment used, notably underground installation of hydrogen tanks.

HEATING

Buildings. Warming Buildings with Refrigerating Equipment, Robertson Matthews. Power, vol. 53, no. 16, April 19, 1921, pp. 628–631, 3 figs. Theoretical study of utilization of low-temperature heat from atmosphere.

Technique. Recent Progress in the Industrial Heating Technique (La technique du chauffage industriel et son enseignement ses bases essentielles et ses progrès récents), Emilo Damour. Chimie & Industrie, vol. 5, no. 3, Mar. 1921, pp. 271–280, 2 figs. Compilation of suggestions in regard to economical utilization of fuel. Prepared under auspices of Central Bureau of Economical Heating, operated under joint control of French Ministries of Industrial Reconstruction and of Labor.

HEATING, ELECTRIC

Industrial. Industrial Electric Heating, A. E. Holloway and H. L. Garbutt. Jl. Electricity & Western Industry, vol. 46, no. 10, May 15, 1921, pp. 486–488 and 517–519, 4 figs. Report of Committee on Industrial Heating to Pacific Coast Section of National Electric Light Association.

HEATING, HOUSE

"Colec" System. The "Colec" System of Central and Radiant Heating, Herbert H. Berry. Elecn., vol. 86, no. 2238, April 8, 1921, pp. 419–420. Combination of coal and electricity for heating houses.

HEATING, STEAM

Central Stations. Load Dispatching in a Central Heating System, J. C. Butler. Power, vol. 53, no. 17, April 26, 1921, pp. 648–651, 7 figs. Meter board in chief engineer's office of Illinois Maintenance Co., Chicago. Flow of steam is measured and recorded.

Return Pipes, Proportions of. The Proportioning of Return Pipes in Steam Heating Installations (Die Bemessung der Kondensleitungen bei Dampfheizungen), O. Liersch. Gesundheits-Ingenieur, vol. 44, no. 7, Feb. 12, 1921, pp. 70–72, 2 figs. Investigation of the field of limitations of the usually employed rules for return pipes. Desiderata for the selection of suitable diameter, the calculation of which, especially for dry returns, is said to be impossible.

HELICOPTERS

Design. The Actual State of the Helicopter Problem, Dr. G. DeBothezat. Aerial Age, vol. 13, no. 11, May 23, 1921, pp. 247–249, 3 figs. Theory of blade-screw action, with notes on problem of descent when motor is stopped.

Karman-Petroczy. Tests Made with Captive Helicopters, Prof. Karman. Flight, vol. 13, no. 18, May 5, 1921, pp. 307–309, 4 figs. Machine consists of three-armed frame made of steel tubes, in which three LeRhone engines are built. Two wooden propellers, each 6 m. in diameter, rotate in opposite directions at about 600 r.p.m.

The Karman-Petroczy Helicopter. Aeronautics, vol. 20, no. 395, May 12, 1921, pp. 342, 2 figs. Three-armed frame made of steel tubes, in which three Le Rhone of 120 hp. each, are mounted. Engines drive two 20-ft. propellers revolving in opposite directions at about 600 r.p.m. Record of lift and stability tests.

Oehmichen-Peugeot. The Oehmichen-Peugeot Helicopter. Engr., vol. 131, no. 3407, April 15, 1921, pp. 411–412, 2 figs. Sustentation is partially derived from hydrogen-filled ballonet. Motor develops 25 hp. Two 2-bladed propellers of 21 ft. diameter rotate in same horizontal plane. Translated from Génie Civil.

Passàt. A New Helicopter. Aeronautics, vol. 20, no. 391, April 14, 1921, p. 253, 1 fig. Passat machine designed to give vertical lift by wing-flapping motion.

Pescara. Testing of Helicopters (Sur les résultats des essais récents d'un hélicoptère), M. Pescara. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 14, April 4, 1921, pp. 845–848, 1 fig. Pescara helicopter. There are two 6.40 meter six-bladed propellers rotating in opposite directions around same vertical axis. Motor is 60-hp. Hispano-Suiza.

The Pescara Helicopter. Aviation, vol. 10, no. 17, April 25, 1921, p. 531, 1 fig. Machine is fitted with two co-axial, six-bladed propellers of 20-ft. diameter. Propellers rotate in opposite directions.

Theory. The Helicopter—II, M. A. S. Riach. Aeronautics, vol. 20, no. 392, April 21, 1921, pp. 280–282, 11 figs. Study of forces produced in helicopter when it has motion of translation as well as motion of ascent vertically.

HOISTING MACHINERY

Design. The Calculation of Hoisting-Machine Elements (Die Berechnung einiger Hebezeuge), Adolf Fleck. Der praktische Maschinen-Konstrukteur, vol. 54, no. 17, Apr. 28, 1921, pp. 129–136, 14 figs. Gives examples of calculations of the most important elements and drives, including hand, electric and hydraulic.

HOISTS

Mine. A Giant Among Mine Hoists. Sci. Am., vol. 124, no. 20, May 14, 1921, p. 381, 1 fig. Mine hoist installed in Lake Superior copper district. Load of 20,000 lb. is raised per trip.

Alden Coal Co. Installs Large Hoist Which Brakes itself If Anything Goes Wrong, Lewis W. LeGrand. Coal Age, vol. 19, no. 18, May 5, 1921 pp. 797–798, 1 fig. Cylindro-conical electrically-driven back-geared 400 hp. platform cage hoist installed in shaft of Alden Coal Co., Alden, Pa.

HOUSING

Europe. Notes on the Housing Situation in Northern Europe. Monthly Labor Rev., vol., 12, no. 4, April 1921, pp. 127–133. Survey of laws passed to relieve emergency and of measures taken to stimulate building of houses.

Industrial. Erecting Houses on Quantity Production Basis. Contract Rec., vol. 35, no. 17, April 27, 1921, pp. 407–409, 10 figs. Typical examples of industrial homes at Walkerville, Ont. Contractor's methods ensure completion of job in 150 working days.

Industrial Housing, Leslie H. Allen. Textile World, vol. 49, no. 18, April 30, 1921, pp. 119–123. Arguments for and against company housing.

HYDRAULIC TURBINES

High-Speed. High-Speed Water Turbines (Schnellaufende Wasserturbinen), Fr. Oesterlen. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 16, Apr. 16, 1921, pp. 409–414, 14 figs. Notes on development of high speed and rotor construction up to 1913; braking tests with a very high-speed turbine by Kaplan in 1913; latest development of the Francis high speed and Kaplan turbines up to rotor with only two rotatable blades; the new Kaplan draft-tube system; draft-tube construction and high-speed rotors in America.

Reaction. Maximum Efficiency of Reaction Turbines (Sur le maximum de rendement des turbines à libre déviation), M. deSparre. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 15, April 11, 1921, pp. 896–899. Theoretical study.

Turgo. The Turgo Impulse Water Turbine. Engr. vol. 131, No. 3407, April 15, 1921, pp. 411, 3 figs. Turgo runner of given dimensions is claimed to have 4 to 5 times capacity of runner of Pelton type of similar dimensions.

HYDROELECTRIC PLANTS

Canada. Canada Shows Rapid Hydro Development, J. B. Challis. Elec. World, vol. 77, no. 17, April 23, 1921, pp. 930–934, 9 figs. Work completed or under way during 1920 totals 650,000 hp. Total developments of Dominion now stand at 2,460,000 hp. Ontario shows greatest progress.

Nipigon Power Development of Ontario Hydro Commission, T. C. James. Elec. News, vol. 30, no. 8, Apr. 15, 1921, pp. 30–37, 20 figs. also in Contract Rec., vol. 35, no. 16, April 20, 1921, pp. 389–395, figs. 71. Twenty-five thousand horsepower now available to be increased to three times that amount as demand develops. Transmission at 110,000 volts.

Denmark. Hydroelectric Power Station in Denmark (Gudenaa-Centralens Indvielse), J. P. Schmidt. Ingeniören, vol. 30, no. 6, Jan. 19, 1921, pp. 29–30. Harnessing the Gudenaa River was commenced in 1918 by construction of dam half a mile long across river valley in order to form a storage reservoir of 1640 acres. Water emerges from reservoir through a 1000-ft. channel to power station with fall of 33 ft. Three duplex turbines are direct coupled to 1500 kw. generators, producing current at 10,000 volts. Total output of 10,000,000 kw-hr. will be obtained annually.

Economics. Economics of Hydro-Electric Development, A. H. Gibson. Engr., vol. 131, nos. 3406–3407, April 8 and 15, 1921, pp. 367–369, 3 figs. and 393–394. Apr. 8: Derivation of formulas from general economic considerations and records of actual cases. Apr. 15: Examination of typical Canadian, American and European installations indicates that total annual costs, excluding transmission and taking 6 per cent as rate of interest on capital, amount very nearly to 9.5 per cent of capital cost.

Efficiency. Increasing the Efficiency of Water-Power Plants, Charles M. Allen. Power, vol. 53, no. 19, May 10, 1921, pp. 761–762, 2 figs. Speed-horse-power curves for various heads. Paper read before Technical Assn. of Pulp and Paper Industry.

Mt. Rainier National Park. Power Generation in Mt. Rainier National Park, C. P. Gordon. Jl. Electricity & Western Industry, vol. 46, no. 9, May 1, 1921, pp. 436–437, 3 figs. Installation for generation of 400 kw. at 2300 volts.

Norway. The Hydroelectric Plants on the Rjukanfos Waterfalls in Norway (Die Wasserkraftwerke am Rjukanfos und am Glomfjord in Norwegen), Gg. v. Troeltsch. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 13, Mar. 26, 1921, pp. 309–314, 8 figs. Notes on the two water-power stations located one directly beneath the other on Norway's most famous waterfall. Details of water inlet from upper to lower plant with 250 m. head; interesting features of the speed and pressure governors of the main turbines of lower station which have output of 16,400 hp. each; upper auxiliary turbine of 7000 hp. with 168 m. head, and use of water for supply of nitrogen factory; lower auxiliary turbines with same output and 250 m. head; interdependence of the two auxiliary turbines, regulation, etc.

Operation. Operation for Maximum Output, and Operating Records, Geo. H. Bragg. Jl. of Electricity & Western Industry, vol. 46, no. 10, May 15, 1921, pp. 504–508, 5 figs. Investigation of a number of western hydrolectric systems. Report of Sub-Committee of the Hydraulic Committee to Pacific Coast Section of National Electric Light Association.

Reservoirs. Importance of Reservoirs and Artificial Lakes in the Production and Distribution of Electrical Energy (Importanza dei serbatoi e dei laghi artificiali nella produzione e distribuzione dell'energia elettrica), Angelo Forti. Giornale del Genio Civile, vol. 59, Feb. 28, 1921, pp. 77–87, 8 figs. Economical study.

I

IMPACT TESTING

Machines. Apparatus for the Measurement of Impact (Apparat zum Messen von Stössen), H. Kreuger. Bauingenieur, vol. 2, no. 4, Feb. 28, 1921, pp. 103–106, 7 figs. Describes apparatus successfully used by author with good results for measuring effects of impact of falling weights and blasting agents against concrete and against other materials and structures under widely different conditions.

INDICATORS

Internal-Combustion-Engine. A New Type of Indicator for High-Speed Internal-Combustion Engines, Augustus Trowbridge. Power, vol. 53, no. 18, May 3, 1921, pp. 704–708, 16 figs. Diagram, electrically transmitted, shows velocity of cylinder pressure changes at every instant instead of actual pressures. Usual form for ascertaining power consumption may be constructed mathematically from it.

INDUSTRIAL CONDITIONS

Europe. Our National Industries and International Business, Dwight T. Farnham. Indus. Management vol. 41, no. 9, May 1, 1921, pp. 331–334. Altered European industrial conditions and their effect on American employer and employee.

INDUSTRIAL MANAGEMENT

Inspection. Principles of Inspection, Louis Ruthenburg and R. A. Crist. Machy. (N. Y.), vol. 27, no. 9, May 1921, pp. 859–862. Review of principles upon which rational inspection methods are based, with special application to interchangeable manufacture.

Putting Inspection Where It Belongs, F. R. Schubert. Factory vol. 26, no. 9, May 1, 1921, pp. 1062–1064, 4 figs. Advises keeping inspection distinct from supervision.

The Organization of the Inspection Department, George S. Radford. Indus. Management, vol. 41, no. 9, May 1, 1921, pp. 356–360, 1 fig. Suggests organization plan for inspection force.

International Organization. Building an International Business Organization, George M. Gales. Indus. Management, vol. 41, no. 9, May 1, 1921, pp. 319–323. Writer's experience in organizing Liggett's International Ltd. Notes on Brittish personnel and English business attitude toward America.

Machine Cards. Alphabetical and Memonic Symbols on Tabulating Machine Cards, C. Moffitt Ford. Indus. Management, vol. 41, no. 9, May 1, 1921, pp. 347–350, 2 figs. Methods for expressing alphabetical, semi-alphabetical and memonic symbols on tabulating machine cards.

Production Systems. Controlling Production. Eng. Production, vol. 2, no. 30, April 28, 1921, pp. 534–537, 4 figs. System of handling components in batches.

Routing Materials. System for Production Control. Machy. (Lond.), vol. 18, no. 450, May 12, 1921, pp. 179–181, 8 figs. Methods employed in plant of American Multigraph Co. for routing and recording progress of work.

Shop Analysis. The Zoning of Jobs, Hugh L. Clary. Indus. Management, vol. 41, no. 9, May 1, 1921, pp. 329–334, 4 figs. Suggests plans for analyzing certain classes of positions as to requirements for compensation.

INDUSTRIAL TRUCKS

Electric. Electric Trucks and Industrial Locomotives—V-VIII. Engr., vol. 131, nos. 3406–9, April 8, 15, 22 and 29, 1921, pp. 374–376, 10 figs., 402–403, 8 figs., 424–426, 8 figs., and 456–458, 8 figs. Typical British designs.

INSULATING MATERIALS

Research. Industrial Research Work on Insulating Materials. Engineering, vol. 111, no. 2886, April 22, 1921, pp. 482–484, 6 figs. Account of work undertaken by Research Committee of Vickers, Ltd., England.

INTERNAL-COMBUSTION ENGINES

Induction Pipes. Induction and Exhaust Pipes. Automobile Engr., vol. 11, no. 149, April 1921, pps 150-152, 18 figs. Résumé of some recent experiment in Germany.

Silencers. Silencers for Internal-Combustion Marine Engines, Engineering, vol. 111, no. 2884, April 8, 1921, p. 422, 4 figs. Mechanism in which energy of exhaust gases is employed to put in motion comparatively large body of cooling water or air.

"Silent Record." "Silent Record" Internal-Combustion Engine. Engineering, vol. 111, no. 2888, May 6, 1921, p. 565, 2 figs. Engine constructed by Record Engineering Co., Burton-on-Trent, England. Engine has four cylinders and two cranks, each pair

of cylinders having common head and valve mixer and being fed with same charge.

[See also AEROPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; GAS ENGINES; GASOLINE ENGINES; INDICATORS; OIL ENGINES.]

IRON

Electrodeposited. "Slip-Lines" and Twinning in Electro-Deposited Iron, W. E. Hughes. Engineering, vol. 111, no. 2889, May 13, 1921, p. 583, 10 figs. partly on suppl. plate. Photomicrographs showing various samples of electrodeposited iron. (Abstract). Paper read before Iron and Steel Inst.

Thermal Analysis. Analysis of Transformations Occurring in Quartz, Iron and Nickel Under Action of Heat (Sur une methode sensible d'analyse thermique et les transformations du quartz, du fer et du nickel), Albert Perrier and F. Wolfers. Revue de Métallurgie, vol. 18, no. 2, Feb. 1921, pp. 111-116, 4 figs. Results of experiments.

J

JIGS

Design. Tool Engineering, Albert A. Dowd and Frank W. Curtis. Am. Mach., vol. 54, nos. 17, 18 and 19, April 28, May 5 and 12, 1921, pp. 720-725, 12 figs. 770-772, 9 figs. and 816-819, 14 figs. Effect of design on manufacture. Consideration of limits of accuracy. Selection of working points. Relation of design to cost of machining. Drill-jig design. Location of rough and finished work. Correct and incorrect location and clamping. Types of jigs.

L

LABOR

Railroad Labor Board. Principles to Govern Agreements Defined by Labor Board. Ry. Mech. Engr., vol. 95, no. 5, May 1921, pp. 287-289. Text of board's decision on national agreements.

LABOR TURNOVER

Records. The analysis of Labor Records, David R. Craig. Indus. Management, vol. 41, no. 9, May 1, 1921, pp. 374-376, 1 fig. Chart for visualizing variables entering into labor turnover.

Reduction. Reducing Foreign Labor Turnover, Arthur Hanko. Indus. Management, vol. 41, no. 9, May 1, 1921, pp. 367-369, 4 figs. Writer's experience in handling foreign workers.

LATHES

Bench. Tools and Methods for Manufacturing Precision Bench Lathes. Machy. (Lond.), vol. 18, nos. 446, 448 and 450, April 14, 28 and May 12, 1921, pp. 33-37, 8 figs., 108-111, 10 figs., and 165-168, 7 figs. Processes used in manufacture of precision bench lathes. Practice in Manufacture of Potter bench lathes. Machining and inspection methods of Toolmakers & Light Machinery, Ltd., England.

Screw-Cutting. Cutting Threads on the Screw-Cutting Lathe (Gewindeschneiden auf der Leitspindeldrehbank), Gustaf Fäldt. Werkstattstechnik, vol. 15, nos. 6 and 7, Mar. 15 and April 1, 1921, pp. 151-155 and 182-188, 64 figs. Deals with shape, operation, position and manipulation of chasers and auxiliary tools, such as gages, supports and grinding devices.

Taper Turning. Taper Turning on Automatic Lathes by use of Concentrically Turned Cams (Kegeldrehen auf selbsttätigen Drehbanken mittels zentrisch gedrehter Vorhaltkurve), Hermann Zimmermann and Max Diener. Werkstattstechnik, vol. 15, no. 7, Apr. 1, 1921, pp. 181-182, 3 figs. Describes device for producing a sufficiently accurate taper.

LAUNCHING

Sideways. Freyssinet Process of Launching Reinforced Concrete Barges Sideways (Transportet lancet ment par le travers de coques de 1000 tonnes suivant les procédés Freyssinet), H. deLauriston. Génie Civil, vol. 78, no. 17, April 23, 1921, pp. 345-350, 8 figs.

LIFTING MAGNETS

Development and Uses. Construction of Lifting Magnets (Der Stand des Lastmagnetbaues), H. Wintermeyer. Elektrotechnischer Anzeiger, vol. 38, nos. 45-46 and 47, Mar. 23 and 24, 1921, pp. 263-265 and 273-274, 8 figs. Notes on present status of development and uses, especially in iron foundries.

Types. Electric Lifting Magnets. Eng. Production, vol. 2, no. 28, April 14, 1921, pp. 472-474, 3 figs. Typical designs. Paper read before Staffordshire Iron & Steel Inst.

LIGHTING

Industrial. The Safety Features of Industrial Lighting, Samuel G. Hibben. Trans. Illuminating Eng. Soc., vol. 16, no. 3, April 30, 1921, pp. 47-55, 12 figs. Relation between light speed and safety in industrial operations.

Technique. Illuminating Engineering and Engineers (Ueber Lichttechnik und Lichttechniker), J. Teichmüller. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 17, Apr. 23, 1921, pp. 435-440. Discussion of what is good illumination and for and with whom the illuminating engineer has to work. Natural and artificial light and lighting. Methods of calculating illumination of open and closed spaces; street lighting, etc. Faults in lighting plant. Schools, research institutes and technical associations for promotion of illuminating technique.

LIGNITE

Briquetting. Manufacturing of Briquets from Lignite. (Die Brikettierung der Braunkohle), H. Landsberg. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 16, Apr. 16, 1921, pp. 415-417, 1 fig. Relations between raw coal and briquets with regard to quantity and heating value, and the power and heat requirements in the manufacture of briquets are derived in a general way and presented with respect to the water volume to be evaporated.

North Dakota. The New Salem Lignite Field, Morton County, North Dakota, Eugene T. Hancock. U. S. Dept. of Interior, U. S. Geological Survey, no. 726-A, May 6, 1921, 39 pp., 9 figs. Fuel is of very low grade. Notes on its utilization.

Utilization. American Lignite Coals, Robert G. Skerrett. Sci. Am., vol. 134, no. 18, April 30, 1921, pp. 344 and 355, 1 fig. Carbonizing and briquetting plant under construction at Bienfait, Saskatchewan.

LOCOMOTIVE BOILERS

Tubes. Notes on Fractures in Locomotive Boiler Tubes, Henry Fowler. Engineering, vol. 121, no. 2885, April 15, 1921, pp. 466-467, 11 figs. Analyses of superheater flue tubes taken out of engine of Midland Ry. locomotive which had run 60,000 miles. Photomicrographs. Paper read before Faraday Soc.

LOCOMOTIVES

Automatic Control of Cut-Off. Automatic Operation of Reverse Lever Accomplished, E. S. Pearce. Ry. Rev. vol. 68, no. 21, May 21, 1921, pp. 763-770, 13 figs. Apparatus consists of two differential valves set at a difference of 1 lb. per sq. in., one shortening cut-off when back pressure increases and the other lengthening cut-off when back pressure decreases.

British. British Locomotives in 1920, J. F. Cairns. Bul. Int. Ry. Assn., vol. 3, no. 4, April 1921, pp. 409-418, 6 figs. Characteristics of leading designs.

Locomotive Building in an English Shop, I. Wm. Chubb. Am. Mach., vol. 54, no. 17, April 28, 1921, pp. 713-719, 19 figs. Manufacturing processes at plant of Armstrong, Whitworth & Co.

New 4-6-4 Type Tank Locomotive, Furness Railway. Ry. Gaz., vol. 34, no. 14, April 8, 1921, pp. 538-539, 3 figs. Characteristics: Total wheel base of engine, 40 ft. 9 in.; diameter of coupled wheels, 5 ft. 8 in.; total length of frame, 45 ft. 9 in.; length of firebox, 8 ft. 6 in.

Connecting Rods. Machining Operations on Locomotive Connecting Rods, Frank A. Stanley. Am. Mach., vol. 54, no. 19, May 12, 1921, pp. 811-813, 12 figs. Practice in shops of Southern Pacific Co. at Sacramento, Cal.

Consolidation. Consolidation Locomotives for the Western Maryland. Ry. Age, vol. 70, no. 19, May 13, 1921, pp. 1117-1120, 8 figs. Comparison of recent designs of Consolidation types.

Most Powerful Consolidation Locomotive Ever Built. Ry. Rev., vol. 68, no. 20, May 14, 1921, pp. 735-737, 1 fig. Characteristics: Tractive effort, 68,200 lb.; cylinders, 27 in. by 32 in.; diameter of drivers, 61 in.; weight on drivers, 268,200 lb.; weight of locomotive, 294,900 lb.; weight of locomotive and tender, 565,000 lb.

Continuous Draft. Continuous Draft in Locomotives (Le tirage continu dans les locomotives), H. Daubois. Arts et Métiers, no. 3, Dec. 1920, pp. 55-57, 2 figs. Disadvantages of pulsating draft produced by exhaust-steam locomotives. Device for rendering draft continuous.

Design. Features of Locomotive Design Affecting Wear on Track. Ry Rev., vol. 68, no. 20, May 14, 1921, pp. 737-739, 4 figs. Paper read before Moncton Branch, Eng. Inst. Canada.

Some Features of the Design of Locomotives Introduced for the Purpose of Modifying Their Effect on the Track, Frank Williams. Jl. Eng. Inst. of Canada, vol. 4, no. 5, May 1921, pp. 309-311, 4 figs. Effect of static load, dynamic augment, impact, lateral flange thrust and abrasion on locomotive design.

The Design of Large Locomotives, M. H. Haig. Mech. Eng., vol. 43, no. 5, May 1921, pp. 311-314, and 326, 6 figs. Features which keep engine in service maximum length of time, reduce maintenance and repair costs, and increase revenue-earning power.

Injectors. The Advantages of the Exhaust Steam Injector, Clarence Roberts. Ry. Mech. Engr., vol. 95, no. 5, May 1921, pp. 290-291, 3 figs. Experience of French and English railways in use of exhaust-steam injector.

Mine. Experience Results in Radical Changes in Mine Locomotives for Heavy Duty, B. S. Beach. Coal Age, vol. 19, no. 18, May 5, 1921, pp. 792-795, 4 figs. Leaf springs and equalizing-bar suspensions make derailments less frequent. Frames cut from steel plate resist inevitable violence in operation. Tandem operation makes bigger trips possible. Electric brakes prevent runaways.

Power Reverse Gear. Tests Demonstrate Precision of New Power Reverse Gear. Ry. Rev., vol. 68, no. 18, April 30, 1921, pp. 668-670, 2 figs. Gear developed by Franklin Ry. Supply Co.

Tests of Franklin Precision Power Reverse Gear. Ry. Age, vol. 70, no. 17, April 29, 1921, pp. 1043-1044, 2 figs. Gear consists of 10 in. by 18 in. cylinder with all parts enclosed. Operating valve is attached to rear end of cylinder and is controlled by hand wheel in cab. This wheel is provided with indicator showing point of cut-off and is connected to gear by operating rod.

Production Methods. Automatic Production Methods in a Locomotive Works. Eng. Production, vol. 2, no. 30, April 28, 1921, pp. 545-550, 15 figs. Methods and tools employed at works at Lancashire & Yorkshire Ry. Co., England.

Reconstruction. Converted Express Locomotives, Lancashire & Yorkshire Railway. Ry. Gaz., vol. 34, no. 15, April 15, 1921, pp. 580-581, 2 figs. Four-cylinder 4-6-0 type engines being converted to superheated steam with larger cylinders, redistribution of weight and other modifications tending to increase their tractive effort and general utility.

Superheater. Modern Express Locomotives, M. Igel, Eng. Progress, vol. 2, no. 3, Mar. 1921, pp. 49-54, 10 figs. German superheating locomotives.

Valve Gears. Railway Machine Shop Practice—II, Edward K. Hammond. Machy. (N. Y.), vol. 27, no. 9, May 1921, pp. 855-858, 8 figs. Methods of machining parts of locomotive valve gears, valves and pistons.

LUBRICANTS

Mineral. The Production of Mineral Lubricants, J. E. Pogue. Sci. Lubrication, vol. 1, no. 3, Mar. 1921, pp. 6-11. Statistics concerning use of petroleum lubricants in U. S.

M

MACHINE SHOPS

Layout. A Modern Tractor Building Machine Shop, J. V. Hunter. Am. Mach., vol. 54, no. 19, May 12, 1921, pp. 804-807. General layout of tools and equipment. Arrangements on cranes and conveyors. Heating and lighting systems.

MACHINE TOOLS

Semi-Automatic. Semi-Automatic Machines for Repetition Precision and Instrument Work—I. Machy. (Lond.), vol. 18, no. 446, April 14, 1921, pp. 49-51, 5 figs. Machine Tools manufactured by Mikron firm of Bienne-Madretsch, Switzerland.

MACHINERY

Depreciation. A Method for the Depreciation of Machinery, H. C. Marris. Eng. & Indus. Management, vol. 5, no. 15, April 14, 1921, p. 426, 1 fig. Method of determining depreciation of machinery. Graph illustrating differences between method of depreciation on logarithmic basis and method of equal annual fractions.

Noise Examination. The Examination of Noise in Mechanisms. Automobile Engr., vol. 11, no. 149, April 1921, pp. 148-149, 6 figs. Dual valve tectoscope for detecting a locating sound.

Vibrations. Eliminating Vibration, an Enemy of Production, Charles L. Hubbard. Factory, vol. 26, no. 9, May 1, 1921, pp. 1075-1078, 10 figs. Methods of insulating against foundation vibration.

MACHINING METHODS

Navy Yard. Large Machine Work at the Puget Sound Navy Yard, Fred H. Colvin. Am. Mach., vol. 54, no. 19, May 12, 1921, pp. 801-803, 9 figs. Machining Operations.

Pump Bodies. Machining Cast Iron Pump Body in 22 Minutes, A. H. Lloyd. Can. Machy., vol. 25, no. 17, April 28, 1921, pp. 32-34, 6 figs. Special chuck jaws are used and taper bore is produced by profile method.

Repetition Work. Interesting Operations on Repetition Work. Eng. Production, vol. 2, no. 29, April 21, 1921, pp. 513-518, 14 figs. Examples of works practice of Messrs. George Kent, England.

Swiveling Slide. Machining a Swiveling Slide. Eng. Production, vol. 2, no. 28, April 14, 1921, pp. 490-491, 5 figs. Notes on methods and tools employed.

MALLEABLE IRON

Casting. Malleable Iron (La fonte malléable), Christian Kluytmans. Fonderie Moderne, no. 3, Mar. 1921, pp. 49-54, 7 figs. European process of casting malleable iron.

Melting. American Malleable Cast Iron—X, H. A. Schwartz. Iron Trade Rev., vol. 68, no. 19, May 12, 1921, pp. 1317-1321, 8 figs. Melting processes.

Foundries. American Malleable Cast Iron—IX, H. A. Schwartz. Iron Trade Rev., vol. 68, no. 17, April 28, 1921, pp. 1175-1180, 7 figs. Notes on organization, layout, labor and equipment of malleable foundry.

MEASUREMENTS

Torque. A Simple Method for Torque Measurement (Ein einfaches Messverfahren Für Drehmomente), W. Schmidt. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 17, Apr. 23, 1921, pp. 441-444, 11 figs. Described method tested in experiments with model propellers and shown to be adaptable for the determination of performance of built-in boat engines.

Torsion. A New Electric Torsion Meter (Ein neuer elektrischer Verdrehungsmesser), Gg. Keinath. Dinglers polytechnisches Jl., vol. 335, no. 25, Dec. 11, 1920, pp. 265-268, 6 figs. Describes electric meter in which the relative position of two cross-sections of a shaft under torsion causes the change of air-gap of two choking coils. The relation of the currents indicated in both coils is measured showing that the indication is independent of oscillations of the auxiliary voltage.

METALS

Electrical Conductivity. The Measurement of Electrical Conductivity in Metals and Alloys at High Temperatures, John L. Haughton. Trans. Faraday Soc., vol. 16, no. 2, Dec. 1920, pp. 392-401, 6 figs. In investigation of constitution of copper-

aluminum-zinc alloys it was found that liquidus and solidus occur, over short range, so close together that it was not possible to distinguish between them by means of thermal curves. Electrical conductivity measurements showed marked changes in direction of curve connecting conductivity and temperature at both solidus and liquidus.

Failure. The Mechanism of Failure of Metals from Internal Stress, W. H. Hatfield. Engineering, vol. 111, no. 2884, April 8, 1921, p. 435. Experiments on wrought iron, brass and silver. It is concluded that, except in certain cases where selective chemical or physico-chemical action causes separation of remains of crystals from each other, fractures are generally due to internal stresses introduced during processes of manufacture. (Abstract.) Paper read before Faraday Soc.

Fatigue. Metal Fatigue Under Repeated Stresses. Jl. Soc. Automotive Engrs., vol 8, no. 5, May 1921, pp. 417–418. Survey of tests by various experimenters. Paper read before Am. Iron & Steel Inst.

Microstructure. Internal Stresses in Relation to Micro-Structure, J. C. W. Humfrey. Engineering, vol. 111, no. 2884, April 8, 1921, pp. 419–420, 2 figs. Study of microstructure of metals and of mechanism of their behavior under plastic deformation. It is suggested that elastic limit be determined by alternating tests rather than by tensile tests. (Abstract.) Paper read before Faraday Soc.

Structure. The Crystalline Structure of Metals, Zay Jeffries and R. S. Archer. Chem. & Metallurgical Eng., vol. 24, no. 18, May 4, 1921, pp. 771–779, 18 figs. Definition of crystallinity. Discussion of methods used in X-ray analysis of atomic spacing and statement of results of such studies made to present time.

METEOROLOGY

Aviation. What the Weather Bureau Does for Air Pilots. Aviation, vol. 10, no. 19, May 9, 1921, pp. 595–597, 1 fig. Upon receipt of telephonic or telegraphic requests giving course of projected flight, Bureau furnishes all information as to fog, smoke, wind, visibility, etc. List of stations to which applications may be addressed.

Weather Control. The Artificial Control of Weather, Napier Shaw. Aeronautics, vol. 20, nos. 391 and 392, April 14 and 21, 1921, pp. 260–261, and 283–284. Also in Aerial Age, vol. 13, no. 9, May 9, pp. 203–205. Methods proposed to British Meteorological Office during war. Dissipation of fog by heat. Lecture before Cambridge Univ. Aeronautical Soc.

METRIC SYSTEM

Arguments Against Adoption in U. S. Why the Metric System Should Not Be Adopted, W. R. Ingalls. Min. & Metallurgy, no. 173, May 1921, pp. 15–16. Reasons against compulsory adoption of metric system in U. S.

Arguments in Favor of Adoption in U. S. Why It Should Be Done the Metric Way, Howard Richards, Jr. Min. & Metallurgy, no. 173, May 1921, pp. 13–14. Advantages of system. Reasons why it should be adopted in U. S.

Compulsory Adoption in U. S. Another Thoroughly Vicious Compulsory Metric Bill is Introduced. Am. Mach., vol. 54, no. 18, May 5, 1921, pp. 800c–800d. Bill introduced in House of Representatives on April 11, 1921 "to fix the metric system of weights and measures as the single standard of weights and measures for certain uses."

South America. Are the South American Countries Metric? C. C. Stutz. Machy. (N. Y.), vol. 27, no. 9, May 1921, pp. 871–872. Confusion due to double and in many cases triple standard of weights and measures.

MILLING

Fixtures. Milling Square-Stem Pinions, Machy. (N. Y.), vol. 27, no. 9, May 1921, pp. 849–851, 4 figs. Fixtures designed by Brown-Lipe-Chapin Co., Syracuse, N. Y.

Production Systems. Interesting Milling Operations. Eng. Production, vol. 2, no. 28, April 14, 1921, pp. 475–480, 15 figs. Production systems at works of Alfred Herbert, England.

MILLING CUTTERS

Face and Form Mills. Metal Cutting Tools,—IX A. L. DeLeeuw. Am. Mach., vol. 54, nos. 17 and 19' April 28 and May 12, 1921, pp. 732–735, 5 figs.,' and 807–810, 13 figs. April 28: Types of face-mills. May 12: Principle of construction of form mill.

MILLING MACHINES

Horizontal. Horizontal Milling Machine. Engineering, vol. 111, no. 2886, April 22, 1921, pp. 484–486 5 figs. Heavy constant-speed-drive horizontal milling machines built by Brown & Sharpe Mfg. Co., Providence, R. I.

MINERS' LAMPS

Gauzes. The Relative Safety of Brass, Copper, and Steel Gauzes in Miners' Flame Safety-Lamps, L. C. Ilsley and A. B. Hooker. U. S. Dept. of Interior, Bur. of Mines, no. 228, 1921, 39 pp., 18 figs. Tests. For conditions of high temperature, steel proved superior to either brass or copper; for low temperatures, advantage of steel over brass or copper was little. Brass proved more satisfactory than copper.

MOLDING METHODS

Austrian Foundry. Molding Cylinders in an Austrian Shop, Charles Irresberger. Foundry, vol. 49, no. 10, May 15, 1921, pp. 383–390, 38 figs. Processes at large foundry in Salzburg, Austria.

Propellers. Molding Propellers by Thacher Process, Enrique Touceda. Iron Age, vol. 107, no 20 May 19, 1921, pp. 1310–1312, 4 figs Method calculated to insure accurate product requiring no machining. Blades and wheels of semi-steel. Paper read before Am. Inst. Min. & Metallurgical Engrs.

MONEL METAL

Reflecting Power. Reflecting Power of Monel Metal, Stellite, and Zinc, W. W. Coblentz U. S. Dept. of Cmmerce, Sci. Paper, Bur. of Standards, no. 379, June 10, 1920, pp. 249–252, 1 fig. It was found that in infra-red spectrum reflectivity of monel metal is practically same as that of nickel. Invisible spectrum reflectivity is slightly lower than that of nickel.

MOTION-PICTURE PROJECTION

Substitute for Reel Film. Is the Reel Film the Only Medium for Photographing of Motion Pictures? (Ist das Filmband das einzige Mittel für Verwirklichung des Laufbildesg?) Karl Gentil. Deutsche Optische Wochenschrift, vol. 7, no. 13, Mar. 27, 1921, pp. 215–217, 4 figs. Discusses possibilities of substituting the mutoscope principle of film leaves in combination with the epidiascope in place of the inflammable reel film of celluloid.

MOTOR TRUCKS

Trailers. The Tracking and Steering of Trailers Analyzed by a Graphic Method, Marius C. Krarup. Automotive Industries, vol. 44, nos. 18 and 19, May 5 and 12, 1921, pp. 955–957, 7 figs., and 1008–1011, 4 figs. Engineering investigation of factors bearing upon steering and tracking of various trailer outfits. Free trailing more suitable for short hauling outfits; and steady steering for slow hauling. Graphic method of analysis.

MOTORCYCLES

Performance. Comparative Motorcycle Performance, D. S. Heather. Automobile Eng., vol. 11, no. 150, May 1921, pp. 187–194, 22 figs. Tests for determining effect of road service irregularities of mud, and also to study deceleration resulting from wind resistance.

MOTORSHIPS

Standardization. Motor Shipbuilding. Times Eng. Supp., no. 558, April 1921, p. 125. Extent to which standardization both of machinery and hulls has been adopted.

O

OIL ENGINES

Fuel Injection. Air-Injection or Mechanical-Injection—IV, J. L. Chaloner. Motorship, vol. 6, no. 5, May 1921, p. 399. Comparison from exhaust temperatures record of relative degree of combustion for two systems. (Concluded.)

OIL FIELDS

Montana. Oil Possibilities in Montana, L. S. Ropes. Eng. & Min. Jl., vol. 111, no. 18, April 30, 1921, pp. 754–755. Favorable oil formations noted in searching for coal fields.

Northwestern Canada. The search for Oil in the West. Can. Min. Jl., vol. 42, no. 16, April 22, 1921, p. 313–323, 20 figs. Account of prospecting operations. Notes on geology of region. Paper read before Can. Inst. Min. & Metallurgy.

South America. The Oil Resources of South America, Henry B. Milner. Min. Mag., vol. 24, no. 4, April 1921, pp. 203–210, 1 fig. Republics of Argentine, Ecuador, Columbia and Venezuela are believed to offer substantial opportunities for profitable investigations because they include areas in which both geological and structural conditions are suitable to oil accumulation.

Underground Conditions. Underground Conditions in Oil Fields, A. W. Ambrose. U. S. Dept. of Interior, Bur. of Mines, bulletin 195, 1921, 248 pp., 43 figs. Points out general method of procedure in studying underground conditions in oil fields, and urges coöperation between technical and practical men in application of engineering methods in developments of oil field.

OIL FUEL

Safety Tank. Safety Tank for Storing Inflammable Liquids (Schutzgas Lagerungen feuergefährlicher Flüssigkeiten), H. von Löw. Automobil-Rundschau, vol. 20, no. 5–6, Mar. 1921, pp. 51–53, 5 figs. Details of different arrangements employing a noninflammable gas under pressure to force out liquid from tank and also to prevent flame or sparks from reaching it.

Specifications. New Fuel Oil Specifications. Oil News, vol. 9, no. 8, April 20, 1921, p. 28. Specifications for various grades used by U. S. Government.

OIL SHALES

Distillation. A Study of the Saturated and Unsaturated Oils from Shale, C. W. Botkin. Chem. & Metallurgical Eng., vol. 24, no. 20, May 18, 1921, pp. 876–880. Investigation of amount and causes of unsaturates in shale oils. Cracking during retorting and distillation accompanied by increase in saturation. Unsaturates vary with nature of shale and methods of pyrolysis.

OIL WELLS

Oil Production. Some principles Governing the Production of Oil Wells, Carl H. Beal and J. O. Lewis. U. S. Dept. of Interior, Bur. of Mines. Bull. 194, 1921, 58 pp., 7 figs. Conditions affecting amount of oil in oil sand. Factors that control rate of production in oil wells. Effect of production of one well on that of another.

OPEN-HEARTH FURNACES

Control Valve. New Oil Fuel Control Valve for Open Hearth Furnaces. Iron Age, vol. 107, no. 18, May 5, 1921, p. 1163. Combination Three-way and proportional discharge valve designed by S. A. Gabriel & Co., Cleveland.

Heat Transfer. Heat Transfer in Open Hearth Furnaces, Henry William Seldon. Blast Furnace & Steel Plant, vol. 9, no. 5, May 1921, pp. 299–304. Survey of experimental studies made by various investigators in different countries.

OXY-ACETYLENE WELDING

Refrigerating Apparatus. Oxy-Acetylene Welding on Refrigerating Apparatus, Fred E. Rogers. Acetylene Jl., vol. 22, no. 11, May 1921, 599–606, 27 figs. Examples illustrating practice. Paper read before Am. Soc. of Refrigerating Engrs.

Tests. An Investigation of Oxy-Acetylene Welding and Cutting Blow-pipes, R. S. Johnston. Mech. Eng., vol. 43, no. 5, May 1921, pp 305–310 and 359, 8 figs. Tests carried out by Bur. of Standards for War Department on commercial apparatus for cutting and welding by oxy-acetylene welding process. Photomicrographs.

[See also AUTOGENOUS WELDING.]

P

PAPER MANUFACTURE

Laboratory Tests. An Outline of Laboratory Tests Used in Pulp and Paper Making, A. Le Chatelier. Paper, vol. 28, no. 8, April 27, 1921, pp. 17–21. Translated from Chimie et Industrie.

PARACHUTES

German Types. Tests on New Types of Parachute. Aeronautics, vol. 20, no. 392, April 21, 1921, pp. 277, 1 fig. Parachutes designed with view to lessening shock on opening. Device submitted in contest organized by German Air Sport Committee under auspices of Sci. Soc. for Aeronautics.

PATTERN MAKING

Shop Organization. A Model Pattern Shop and Storage Building, Gilbert L. Lacher. Iron Age, vol. 107, no. 18, May 5, 1921, pp. 1165–1168, 7 figs. Pattern storage of Whiting Corporation, Harvey, Ill.

PEAT

Distillation. The Distillation of Peat and Wood (Die Entgasung von Torf und Holz), B. Waeser. Zeit. für angewandte Chemie, vol. 34, no. 13, Feb. 15, 1921, pp. 51–54, 2 figs. Discussion of different processes and plants.

Utilization. Peat Power Plants in Germany. Engr., vol. 131, no. 3408, April 22, 1921, pp. 422–423, 1 fig. Scheme involving construction of 7 power plants, 5 operated with peat and lignite and 2 hydroelectric plants. Plants are to be interconnected and will deliver power to country at 150,000 volts.

PHOSPHOR BRONZE

Tests. Note on Phosphor Bronze Bars, John Arnott. Engineering, vol. 121, no. 2885, April 15, 1921, pp. 474, 2 figs. Tensile tests. (Abstract.) Paper read before Faraday Soc.

PIG IRON

Foundry. Some Defects in Foundry Pig Irons, Y. A. Dyer. Iron Age, vol. 107, no. 17, April 28, 1921, pp. 1093–1094. Examples of bad effect of iron oxide.

PIPE BENDS

Design. The Design of Pipe Bends for Expansion in Pipe Lines, J. G. Stewart. Power, vol. 53, no. 19, May 10, 1921, pp. 742–743, 4 figs. Chart for computing expansion of U-bends of commercial steel pipe with nominal diameters 2 in.–12 in. inclusive.

PIPE, CAST-IRON

Centrifugal Process. Cast Iron Pipe Made by the de Lavaud Process, Peter Gillespie. Can. Engr., vol. 40, no. 19, May 12, 1921, pp. 454–455, 4 figs. Comparative weights of pipe made by centrifugal process and sand mold pipe.

PIPE, CONCRETE

Pressure. New Type Concrete Pressure Pipe Successful in Severe Test. Concrete Products, vol. 20, no. 4, April 1921, pp. 15–20, 9 figs. Steel cylinder encased in concrete the latter being reinforced by wire mesh or bars on both sides of steel cylinder.

Tests. New Concrete Pressure Pipe Tested. Concrete, vol. 18, no. 5, May 1921, pp. 242–244, 4 figs. Pipe consisting of steel cylinder and lap horizontal joint welded on outside only, the whole being encased in concrete.

PIPING

Calculation Chart. A Chart for the Calculation of Steam and Air Piping (Tafel für die Berechnung von Dampf- und Luftleitungen), Alexander Fisher. Zeit. des. Vereines deutscher Ingenieure, vol. 65, no. 18, Apr. 30, 1921, pp. 469–470, 1 fig. Alignment chart is developed which permits a rapid graphic determination of pressure drop, diameter of pipe and flow per second.

PISTONS

Aluminum. Aluminum Pistons, Frank Jardine and Ferdinand Jehle. Jl. Soc. Automotive Engrs., vol. 8, no. 5, May 1921, pp. 397–403, 9 figs. Survey of recent developments in construction of aluminum pistons, and suggestions in regard to their design.

Aluminum Pistons, Frank Jardine and Ferdinand Jehle. Aerial Age, vol. 13, no. 11, May 23, 1921, pp.

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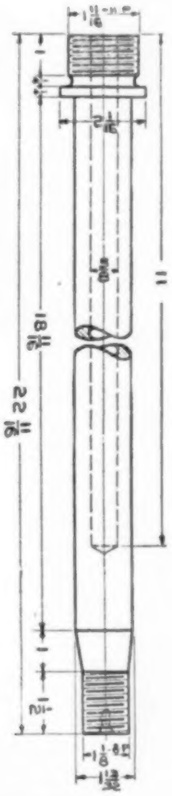

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Andersen, Meyer & Company, Ltd., Shanghai.
Brossard-Mopin & Company, Saigon, Singapore, Haiphong.

ENGINEERING INDEX (Continued)

250–253, 8 figs. Tests conducted to measure operating temperatures of pistons on Liberty engines. (Concluded.)

Machining Methods. Machining Motor Pistons, C. H. Dengler. Machy. (N. Y.), vol. 27, no. 9, May 1921, pp. 878–879, 3 figs. Successive steps and equipment employed in machining pistons for high-grade automobile.

PLANING

Production Systems. Production Planing in Machine Tool Plants. Machy. (N. Y.), vol. 27, no. 9, May 1921, pp. 833–837, 4 figs. Efficiency factors in production planing. Points to observe in obtaining maximum output from planers.

POLES, WOODEN

Preservative Treatment. The Impregnation of Wooden Poles for Long-Distance Stations (Aufgaben und Ziele der Imprägnierung von Holzmasten für Ueberland-Zentralen). Friedrich Moll. Zeit. für angewandte Chemie, vol. 34, no. 19, Mar. 8, 1921, pp. 81–84, 7 figs. Notes on nature of wood impregnation and experiences in recent years.

The Impregnation of Wooden Poles from an Economic Standpoint (Die Wirtschaftlichkeit der Imprägnierung hölzerner Leitungsmasten). Friedrich Moll. Elektrische Kraftbetriebe u. Bahnen, vol. 19, no. 6, Mar. 24, 1921, pp. 61–63, 3 figs. Four different impregnation processes are recommended.

PORTS

Dunkirk. The Port of Dunkirk. Bulletin Technique du Bureau Veritas, vol. 3, no. 4, April 1921, pp. 91–93, 2 figs. Mechanical equipment for handling cargo.

POWER GENERATION

Victoria, Australia. Power for Victorian Industries. Supp. to Indus. Australian & Min. Standard, Mar. 17, 1921, 79 pp., 77 figs. Electric power scheme authorized and initiated by state government of Victoria and being carried out effect by Victorian commission. Scheme involves development of water power and utilization of brown-coal deposits.

PROPELLERS, SHIP

Manufacture. Propellers Cast in British Shop, Wesley J. Lambert. Foundry, vol. 49, nos. 9 and 10, May 1 and 15, 1921, pp. 351–355, 9 figs., and 391–396, 6 figs. Physical properties of several bronzes used for propellers given. Details of pattern equipment including striking board illustrated and methods of securing correct pitch described. Method of making cope. Melting methods and pyrometric control.

The Manufacture of High-Class Marine Propellers, Wesley J. Lambert. Trans. Inst. of Mar. Engrs., vol. 32, Mar. 1921, pp. 419–457 and (discussion) pp. 457–470, 12 figs. Practice at works of Deptford & Charlton, England.

PULVERIZED COAL

Dust Explosions. How to Protect Pulverized-Coal Plants From Dust Explosions and Fires. Coal Age, vol. 19, no. 17, April 28, 1921, pp. 746–749. Vacuum system should remove dust from air in building; driers should not be heated excessively; air supply for burning coal should be kept from forcing its way into coal supply line.

[See also BOILER FIRING, Pulverized Coal; BOILERS, WATER-TUBE, Tests.]

PUMPING STATIONS

Air-Lift. A Modern Air-Lift Pumping Plant, John Oliphant. Ry. Maintenance Engr., vol. 17, no. 5, May 1921, pp. 172–174, 5 figs. Installation of Philadelphia & Reading Railway at Telford, Pa. 100 gal. are pumped per min. from well 350 ft. deep, 10 in. in diameter.

PUMPS

Exeter Rotary. By Movement of a Rotor Three Spaces Enlarge and Contract, Thus Drawing and Expelling Water. Coal Age, vol. 19, no. 18, May 5, 1921, pp. 805–806, 2 figs.

New Type Exeter Rotary Pump Works on Novel Principle and Wears But Little, S. H. Farkas. Nautical Gaz., vol. 101, no. 19, May 7, 1921, pp. 597–609, 4 figs. Underlying principle of operation is variant of square-hole drilling device in which triangular bit functions inside restraining square former of equal size. Irregular spaces, increasing and diminishing in volume as two rotate together, admit and eject fluid.

Mercury Vapor. A Mercury Vapor Pump (Quecksilberdampfpumpe nach W. Friedrichs). Zeit. für angewandte Chemie, vol. 34, no. 11, Feb. 8, 1921, p. 46, 1 fig. Details of pumps constructed by Greiner & Friedrichs Glass Works, Stützerbach.

Submersible. Submersible Electric Pumps. Iron & Coal Trades Rev., vol. 102, no. 2771, April 8, 1921, pp. 493, 3 figs. Pumps manufactured by Submersible Motors, Ltd., Middlesex, England.

Vacuum. Dry-Vacuum Pump Capacity Tests, Snowden B. Redfield. Mech. Eng., vol. 43, no. 5, May 1921, pp. 315–318, 4 figs. Method employing low-pressure nozzle for air measurements. Typical volumetric-efficiency curves.

PUMPS, CENTRIFUGAL

Pullen. A New Low-Lift Centrifugal Pump. Machy. Market, no. 1067, April 15, 1921, p. 29, 2 figs. Pullen low-lift pump. Impeller member has vanes shrouded both sides, also impeller member and casing are fitted with renewable wearing rings.

PYROMETRY

Industrial Applications. Pyrometric Practice, Paul D. Foote, C. O. Fairchild and T. R. Harrison. U. S. Dept. of Commerce, Technologic Papers, Bur. of Standards, no. 170, Feb. 16, 1921, 326 pp., 185 figs. Survey of practical methods in use in industries in 1920.

R

RADIOMETALLOGRAPHY

Developments. X-Rays and Their Industrial Applications. Engineering, vol. 111, no. 2884, April 8, 1921, pp. 412–415, 10 figs. Developments in radiometallographic examination of materials.

RAILS

Electric Welding. See ELECTRIC WELDING, Rails.

Fractures. Internal Fractures in Steel Rails, Henry S. Rawdon. Engineering, vol. 121, no. 2885, April 15, 1921, pp. 470–471, 2 figs. Microscopic examinations of "transverse fissures." (Abstract.) Paper read before Faraday Soc.

Standardization. New Standard Rail Sections for French Roads. Ry. Age, vol. 70, no. 19, pp. 1129. Four sections adopted are 26-kg. section for narrow gage tracks, 36-kg. section for light traffic, standard-gage lines, 46-kg. section for light traffic, standard-gage lines and 55-kg. section for use in tunnels where action of moisture and smoke results in rapid loss of metal.

RAILWAY ELECTRIFICATION

Economics. Economic Aspect of Railway Electrification, A. H. Armstrong. Gen. Elec. Rev., vol. 24, no. 5, May 1921, pp. 405–413, 26 figs. Electrification advocated as means for solving national transportation problem.

Electrification of Steam Roads an Economic Necessity, A. H. Armstrong. Elec. Rev., (Chicago) vol. 78, no. 19, May 7, 1921, pp. 723–727, 2 figs. Economies in fuel and labor effected by change to electric motive power.

Rational Electrification of Steam Railroads, George R. Henderson. Ry. Age, vol. 70, no. 17, April 29, 1921, pp. 1037–1038, 1 fig. Method for determining what values of profile and traffic density make electric operation desirable.

Switzerland. Electrification of St. Gotthard Line, Switzerland, Hans W. Schuler. Ry. Age, vol. 70, no. 19, May 13, 1921, pp. 1107–1112, 13 figs. Line extends from Lucerne to Chiasso on Italian border, distance of 180 miles. There is average grade of 2.5 per cent for 30 miles. Current at 15,000 volts is supplied to locomotives.

RAILWAY MAINTENANCE

Methods. Developing Thoroughness and Permanency. Ry. Maintenance Engr., vol. 17, no. 5, May 1921, pp. 160–164, 4 figs. Engineering and maintenance methods of Lackawanna Railroad.

RAILWAY MOTOR CARS

Diesel-Electric. Diesel-Electric Cars (Les automotrices Diesel-électriques), Lucien Pahin. Industrie Électrique, vol. 30, no. 692, April 25, 1921, pp. 145–150, 5 figs. Motor cars used in Swedish railways.

RAILWAY OPERATION

Cost Accounting. The earnings of Individual Passenger Trains, T. W. Mathews. Ry. Age, vol. 70, no. 16, April 22, 1921, pp. 981–983, 4 figs. Method for determining whether selected trains pay out of pocket or other costs.

Freight Trains. Effect of Train Speed on Energy Consumption, G. S. Chiles and R. G. Kelley. Ry. Age, vol. 70, no. 18, May 6, 1921, pp. 1083–1084, 2 figs. Charts showing relation between resistance and speed for various average weights per car.

Train Control. Train Operation and Automatic Train Control, J. B. Latimer. Ry. Age, vol. 70, no. 16, April 22, 1921, pp. 977–979. Caution signals, property located with audible signals suggested as means of remedying collision problem.

Train Despatching. A Complete Train Despatching System. Ry. Signal Engr., vol. 14, no. 5, May 1921, pp. 184–187, 4 figs. Practice of Lancashire & Yorkshire Ry., England. All train movements are controlled from one center office. From Modern Transport, Lond.

RAILWAY REPAIR SHOPS

Electric Welding. Railroad Shop Notes, S. Ashton Hand. Am. Mach., vol. 54, no. 18, May 5, 1921, pp. 773–777, 19 figs. Repairs on broken cylinders by electric welding. Gage for setting half-cranks on Walschaerts valve gears.

RAILWAY SIGNALING

Overrunning Signals. Means for Preventing Overrunning Signals Standing at Danger, H. Möllering. Bul. Int. Ry. Assn., vol. 3, no. 4, April 1921, pp. 419–430, 1 fig. Signaling systems used by German Railways. Paper read before Electrotechnical Soc. of Dresden.

RAILWAY SWITCHES

Control. Outlying Switch Control Facilities Train Movements, C. C. Anthony. Ry. Age, vol. 70, no. 18, May 6, 1921, pp. 1077–1079. Development of low-voltage mechanisms controlled from central point.

Interlocking. New Interlocking on the Boston Elevated, W. C. Smith. Ry. Signal Engr., vol. 14, no. 5, May 1921, pp. 173–178, 10 figs. Electropneumatic plant with A. C. control and color light signals gives speed-signaling indications.

RAILWAY TIES

Reinforced-Concrete. The Ickes Railway Tie. Concrete, vol. 18, no. 5, May 1921, pp. 252–253, 10 figs. Main feature consists of lateral enlargements immediately under rail, making longitudinal support of rail at this point 21 in. instead of 8 in. for wooden tie. Tie is made in three parts, which are connected and drawn together by means of 3/8-in. by 2-in. steel bar.

Steel vs. Wood. Steel Sleepers Compared with Wood. Indian Eng., vol. 69, no. 15, April 9, 1921, p. 203. Empirical formula for computing relative economy of using steel or wooden ties, obtained from records of service of both of these types of ties in the Baden Ry., Germany.

RAILWAY TRACK

Standardization of Material. The Standardization of Material in France and in Germany (Die Normalisierung des Oberbaumaterials in Frankreich und in Deutschland). P. Müller. Elektrische Kraftbetriebe u. Bahnen, vol. 19, no. 6, Mar. 24, 1921, pp. 63–65. Comparison of relative merits of both systems. Whereas in Germany the standardization committee is a voluntary organization and no one is compelled to adopt the established standards, in France the standardization commission is appointed by Bureau of Public Works and Bureau of Trade.

Tie Plates. Service Stresses in Tie Plates, E. P. Gowing. Ry. Rev., vol. 68, no. 17, April 23, 1921, pp. 644–645 and 650–651, 4 figs. Graphs showing distribution of pressure. From Indian Engineering.

Weed Burners. Southern Road Develops High Power Weed Burner. Ry. Age, vol. 70, no. 17, April 29, 1921, pp. 1033–1034. Apparatus developed in shops of Texas & Pacific. Heat at temperature of 1400 to 1500 deg. fahr. is blown upon vegetation beneath hood 38 ft. long suspended over track, giving length of contact sufficient to destroy vegetation while burner is moving five miles per hour.

REFRIGERATING PLANTS

Operation. Refrigerating Plant Economies and Capacities, I. L. Kentish-Rankin. Power Plant Eng., vol. 25, no. 9, May 1, 1921, pp. 471–477, 8 figs. Methods for increasing economy and capacity of plant.

RESEARCH

Industrial. A Modern Research Laboratory. Automobile Eng., vol. 11, no. 150, May 1921, pp. 176–177, 7 figs. Devices which have been evolved at industrial research laboratories operated by Rudge-Whitworth, England.

The Central Research Laboratory of the General Motors Company, J. Edward Schipper. Automotive Industries, vol. 44, no. 17, April 28, 1921, pp. 900–901, 1 fig. Occupies building 1000 ft. long by 270 ft. wide in Moraine City, suburb of Dayton, and is operated as independent unit of G. M. C. but in coöperation with various automobile and parts plants of company, under direction of C. F. Kettering and staff of specialists.

The Conduction of Research, F. H. Norton. Sci. Monthly, vol. 12, no. 5, May 1921, pp. 424–433. Economical advantages of industrial research. Procedure in carrying out research.

The Products of a Works Laboratory. Engr., vol. 131, no. 3408, April 22, 1921, pp. 430–431, 10 figs. Apparatus used in work done at research laboratory in Conventry works of Rudge-Whitworth, England.

Government-Conducted. Scientific and Engineering Work of the Government, Its Cost and Its Value, E. B. Rosa. Eng. & Contracting, vol. 55, no. 20, May 18, 1921, pp. 487–490. Activities of scientific and engineering branches of national Government, with figures relating to economic value of such work. Paper read before Washington Section, The American Society of Mechanical Engineers.

RIVETS

Design. Rivet-Head Shapes (Nietkopfformen) W. Schulz. Elektrotechnische Rundschau, vol. 38, no. 4, Feb. 21, 1921, pp. 21–24, 18 figs. Determination of weight of rivet heads, and of length of radii of arcs forming contour of sections of round-head rivets.

ROCK DRILLS

Rotary Electric. The New Pillar Drill of the Siemens-Schuckert Works (Die neue Säulendrehbohrmaschine der Siemens-Schuckertwerke), H. Bäumer. Kali, vol. 15, no. 6, Mar. 15, 1921, pp. 94–100, 11 figs. Details of latest improved type of Siemens-Schuckert drill, the GFD 3000, with 3-phase motor requiring 1.65 kw. Advantages and useful possibilities.

ROLLING MILLS

Electrically Driven. Some Methods of Obtaining Adjustable Speed with Electrically Driven Rolling Mills, K. A. Pauly. Gen. Elec. Rev., vol. 24, no. 5, May 1921, pp. 422–432, 15 figs. Discussion of Merits of Scherbius system of speed control, both single range and double range in which slip energy of main motor is returned to system as electric energy. Comparison is made with Kraemer or synchronous converter system in which slip energy is returned to main motor shaft.

Rerolling Rails. Rerolling Rails at Sweet's Steel Co., Sidney G. Koon. Iron Age, vol. 107, no. 19, May 12, 1921, pp. 1227–1232, 8 figs. Recovery of 80 per cent of old tonnage. Rails split for rolling angles and flats for fence posts and bedsteads.

Roll Design. Foreign Methods of Roll Design, H. R. Ronnebeck. Iron & Coal Trades Rev., vol. 102, no. 2771, April 8, 1921, pp. 490–492, 18 figs. Comparison of German and American practices. Paper read before Cleveland Instn. Engrs.

MAKING EFFECTIVE USE OF RADIANT ENERGY

The importance of Radiant Energy in boiler and stoker practice is strongly emphasized by Prof. A. G. Christie of Johns Hopkins University in an article in "Power" for April 12.

The conclusions reached are:

> "First, that direct radiation is an important source of heat in boiler furnaces which should be carefully considered in both design and operation.
>
> Second, that the highest possible furnace and fuel-bed surface temperatures should be maintained, so as to emit the greatest amount of radiant energy; and that furnace design and operation should be studied to insure *continuous removal of ash and cinder from this hot surface.*
>
> Third, that the greatest possible amount of dull metallic boiler surface should be arranged *to "see" the fire:* that is, to receive this radiant energy directly, and that these surfaces must be kept free of dust and cinders by effective cleaning devices."

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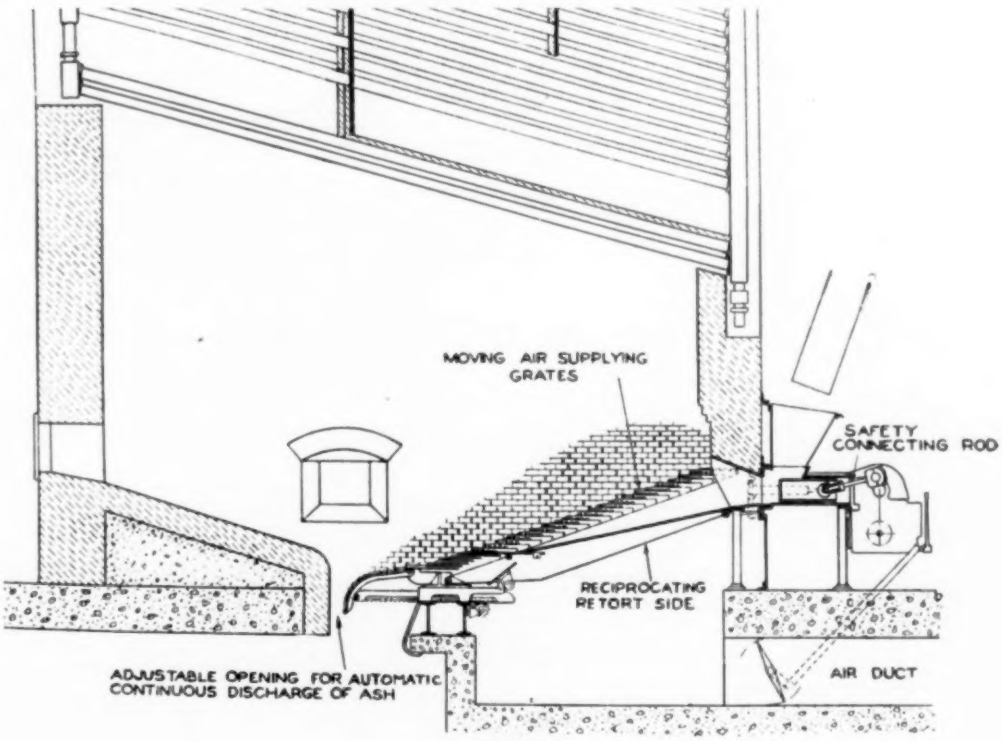

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ENGINEERING INDEX (Continued)

S

SCRAPING MACHINES

Compressed-Air. The Use of Scrapers in Metal Mines, Lucien Eaton. Compressed Air Mag., vol. 26, no. 5, May 1921, pp. 10065–10075. Structural characteristics of typical scraping machines.

SCREW THREADS

Methods of Producing. Various Methods of Producing Threads, J. H. Moore. Can. Machy., vol. 25, no. 17, April 28, 1921, pp. 25–31, 23 figs. Threading locomotive set screws. Steel axles. Special nuts. Tractor axles; worms; lead screws; fine pitch threads and internal threads.

SCREWS

Gaging. Gauging and Fine Measurements—I, A. C. Wickman. Machy. (Lond.), vol. 18, no. 446, April 14, 1921, pp. 52–55, 8 figs. Application to production of screws.

SLAG

Utilization and Agriculture. Basic Slags: Their Production and Utilization in Agriculture. Trans. Faraday Soc., vol. 16, no. 2, Dec. 1920, pp. 261–335. Symposium. Papers presented were: The Utilization of Basic Slag; The Physical Chemistry of Basic Slags; The National Aspects of the Case for Increasing Supplies of Basic Slag; The Demand for Basic Slag; Basic Slag and Its Place in the Development of Agriculture; A Comparison of the Effect of Various Types of Open Hearth Basic Slags on Grassland; Solubility of Basic Slags; The Improvement of Low Grade Basic Slag; Formation of Basic Slag in the Manufacture of Steel.

SPRINGS

Design. Formulas for Spring Design, Edward Jacobi. Machy. (N.Y.), vol. 27, no. 9, May 1921, pp. 882–884, 4 figs. Empirical formulas tried out in designing plants of Milwaukee manufacturers.

Helical. Design of Helical Springs, Joseph Kaye Wood. Am. Mach., vol. 54, no. 18, May 5, 1921, pp. 780–784, 3 figs. Importance of and factors entering into "material index." Determination of torsional modulus of elasticity. Control of unit fiber stress.

Leaf. Design and Heat Treatment of Leaf Springs, H. E. Hemstreet. Forging & Heat Treating, vol. 7, no. 4, April 1921, pp. 240–242. Times and temperature for hardening and drawing.

Testing. Magnetic Spring Testing, T. Spooner and I. F. Kinnard. Am. Soc. for Testing Matls., advance paper, 8 pp. 3 figs. Apparatus used and results obtained in magnetic tests on helical steel springs. Hysteresis method of testing is believed to furnish ready commercial method of checking quality and heat treatment of finished springs.

Spring Testing. Automobile Engr., vol. 11, no. 149, April 1921, pp. 142–144, 5 figs. Amsler universal machine for testing springs under pressure of from 2 to 100 tons.

STACKS

Steel, Cement-Gun Lining. The Conservation of Steel Stacks Weakened by Corrosion, John V. Schaefer. Eng. World, vol. 18, no. 5, May 1921, pp. 321–323, 5 figs. Reconstruction of corroded steel stack by cement-gun lining.

STAMPING

Typical Operations. The Economics of Drawing and Forming Metals, Robert Holmes. Raw Material, vol. 4, no. 4, April 1921, pp. 124–128, 13 figs. Typical stamping operations. Records of costs.

STANDARDIZATION

Economics. Standardization of Products, Melvin T. Copeland. Bul. Taylor Soc., vol. 6, no. 2, April 1921, pp. 55–64 and (discussion) pp. 64–76. Economical advantages of standardization.

Fillets for Revolving Parts. Standard Fillets for Revolving Parts (Normale Abrundungen an Drehteilen), K. Schenck. Der praktische Maschinen-Konstrukteur, vol. 53, no. 51, Dec. 23, 1920, pp. 436–438, 3 figs. Suggestions for carrying out a standardization system for filleting shoulders of shafts and rounding off the corresponding portion of brasses or bearings in which they revolve.

Machinery. Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, vol. 3, no. 15, Apr. 25, 1921, pp. 207–219, 16 figs. Proposals of Board of Directors for plug gages, limit gages, holders, measuring disks and holders, and end gages. Proposed new standards for circular dies, die caps and holders.

Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, vol. 3, no. 14, Apr. 10, 1921, pp. 187–199, 20 figs. Proposal of Board of Directors for holes, keyways and arbors for cutters, reamers and countersinks; hand screw taps for Whitworth, metric and pipe threads; nut taps; screw die taps; hand jaw and machine jaw taps. Proposed standard for molded pieces for drain pipes.

The Interdependence of Standards with Special Regard to Preferential Dimensions (Die Abhängigkeit der Normen voneinander unter besonderer Berücksichtigung der Vorzugsmasse), R. Koch. Betrieb, vol. 3, nos. 13 and 14, Mar. 25 and Apr. 10, 1921, pp. 94–101 and 106–108, 10 figs. Presents table containing series of preferential dimensions developed by working committee for standard numerals and explains their practical application. Report of Federation of German Works Engrs.

STEAM

Superheated, Specific Heat of. The Determination of the Specific Heat of Superheated Steam from Throttling Tests (Ueber die Bestimmung der spezifischen Wärme des überhitzten Wasserdampfes aus Drosselversuchen) Karl Hencky. Zeit. des Bayerischen Revisions-Vereins, vol. 25, nos. 6 and 7, Mar. 31 and Apr. 15, 1921, pp. 41–43 and 52–54, 2 figs. Critical discussion of tests by Grindley and Griessmann; notes on accuracy obtainable with throttling tests. Recommendations based on experiences with the throttling calorimeter.

STEAM-ELECTRIC PLANTS

France. French Electric Plant, Carroll F. Merriam, Nat. Engr., vol. 25, no. 5, May 1921, pp. 214–217, 3 figs. Steam-electric plant of gas company of Lyons.

Philadelphia. Compact Reinforced-Concrete Generating Station at Philadelphia. Elec. World, vol. 77, no. 21, May 21, 1921, pp. 1145–1151, 18 figs. Steam-electric station with generating capacity of 180,000 kw. Attention is directed to coal-handling facilities and furnace construction.

STEAM METERS

New Types. Power Consumption and Steam Meters (Ueber Betriebskontrolle und Dampfmesser), Anton Gramberg. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 15, Apr. 9, 1921, pp. 391–393, 4 figs. Suggestions for equipment and superintendence of factories operating with waste heat. Experiences with different types of steam meters and description of two new types.

STEAM POWER PLANTS

New Plant. A Plant Built for Service. Power Plant Eng., vol. 25, no. 9, May 1, 1921, pp. 449–454, 11 figs. Plant supplying steam for power and heating purposes.

STEAM SHOVELS

Loading Slag with. Operations of the Birmingham Slag Company. Excavating Engr., vol. 15, no. 5, May 1921, pp. 151–154, 6 figs. Company is operating eight steam shovels in and around Birmingham, loading slag. Description of plants at Ensley and Alabama City, Ala.

STEAM TURBINES

Developments. Some Recent Developments in Large Steam Turbine Practice, K. Baumann. Eng., vol. 111, nos. 2884, 2885, 2886, 2887, 2888 and 2889, Apr. 8, 15, 22, 29, May 6 and 13, 1921, pp. 435–439, 449–453, 501–504, 532–535, 567–571 and 597–600, 38 figs. Apr. 8: Outline of turbine practice from 1912 to 1921 based on published records and other information, indicating circumstances which have resulted in "race for maximum output at highest possible speed." Apr. 15: Factors affecting development of large turbines. Apr. 22: Basis of calculations for improvement in heat consumption possible with improved steam conditions. Apr. 29: Economical rating of given turbine frame. May 6: Comparison of different types of turbo machines. May 13: Tests on steam consumption of large turbines. Paper read before Instn. Elec. Engrs.

Lubrication. Keeping Steam Turbine Lubricating Oil in Good Condition, Charles H. Bromley. Gen. Elec. Rev., vol. 24, no. 5, May 1921, pp. 414–421, 7 figs. Various processes employed, including batch system, continuous filtration, and continuous by-pass are described, and list of requirements of efficient oil filtration system is given.

STEEL

Alloy. See ALLOY STEELS.

Automobile. Further Notes on Automobile Steels, W. H. Hatfield. Automobile Engr., vol. 11, no. 149, April 1921, pp. 153–158, 4 figs. Experiments at Brown-Firth Research Laboratories to establish actual fatigue range of different steels.

Carbon Determination. Electrolytic Resistance Method for Determining Carbon in Steel, J. R. Cain, L. C. Maxwell. U. S. Dept. of Commerce, Technologic Papers, Bur. of Standards, no. 141, Dec. 6, 1919, 21 pp. 6 figs. Method for determining carbon dioxide by absorbing it in barium hydroxide solution and measuring resistance change of solution in relation to its concentration. Suitable absorption vessel with electrolytic resistance cell incorporated.

Intercrystalline Fracture. Inter-Crystalline Fracture in Steel, D. Hanson. Engineering, vol. 121, no. 2885, April 15, 1921, pp. 467–469, 7 figs. Examination of photomicrographs. It is concluded that there is no essential difference between iron and steel and non-ferrous metals in regard to season cracking. (Abstract.) Paper read before Faraday Soc.

Inter-Crystalline Cracking of Mild Steel in Salt Solutions, J. A. Jones. Engineering, vol. 121, no. 2885, April 15, 1921, pp. 469–470, 7 figs. Photomicrographic and chemical analyses. It is believed one of determining factors in production of cracks is presence of internal or applied tensile stress, and fracture occurs only when these stresses are above certain value. Condition of slightly elevated temperature alone was not found to be responsible for producing cracks in internally stressed steel. (Abstract.) Paper read before Faraday Soc.

Piping and Segregation. Shrinkage-Hole Formation and Segregations in Steel Ingots (Ueber Lunkerbildung und Seigerungserscheinungen in silizierten Stahlblöcken), A. Brüninghaus and Fr. Heinrich. Stahl u. Eisen, vol. 41, no. 15, Apr. 14, 1921, pp. 497–510, 17 figs. Marked difference in casting methods employed with steel with silicon added were not observed. Results of investigations and conclusions. Discussion.

Rock-Drill. Breakage and Heat Treatment of Rock-Drill, Benjamin Tillson. Min. & Metallurgy, no. 173, May 1921, pp. 38–39 and 42–43, 4 figs. Service tests on 7 brands of rock drill steel. 246 pieces out of 271 were broken during tests; 25 pieces averaged 114 ft. without breaking.

Shipbuilding. Steel and Iron for Shipbuilding Purposes, Horace Holden Thayer. Mar. Eng., vol. 26, no. 5, May 1921, pp. 370–375. Notes on practice, requirements, specifications, methods of ordering shipments, etc.

Tests. Impact Tests on Cast Steel, F. C. Langenberg. Am. Soc. for Testing Matls., advance paper, 11 pp. 4 figs. Tests made to determine effect of phosphorus upon physical properties of cast steel, also effect of heat treatment upon acid open-hearth cast steel.

Tool. Action of Internal Stress on Tool Steel, J. Neil Greenwood. Engineering, vol. 111, no. 2887, April 29, 1921, pp. 535–537, 1 fig. Origin of internal stresses in pure metals and alloys are grouped in two main classes: those due to distortion by cold working and those resulting from suppression of phase changes by rapid cooling. Conditions governing hardening of steel are set out in detail and volume changes causing internal stresses are analyzed. Phenomena of spontaneous change are examined in light of results published by Matsushita. Paper read at joint meeting of Faraday Soc. with other institutions.

Tungsten. Structure of Tungsten Steels. Chem. & Metallurgical Eng., vol. 24, no. 17, April 27, 1921, pp. 745–748, 18 figs. Review of Honda and Murakami's work, presenting their principal conclusions as to structure and constitution of tungsten iron carbon alloys. Reactions between iron tungstide and iron and tungsten carbides.

STEEL, HEAT TREATMENT OF

Hardening. The Hardening of Steel (Ueber das Härten des Stahls), B. Strauss. Betrieb, vol. 3, no. 14, Apr. 10, 1921, pp. 400–405, 18 figs. Discusses theory of hardness of steel based on results of most recent researches, and its dependence on composition, temperature and speed of cooling off. Origin of pressure cracks and the close relationship between volume and hardness of steel.

Quenching Cracks. On Cause of Quenching Cracks Kotaro Honda, Tokujiro Matsushita and Sakae Idei. Engineering, vol. 111, no. 2889, May 13, 1921, pp. 595–597, 9 figs. It is concluded from tests that in quenched steel a certain amount of austenite is generally present intermingled in martensite. Amount of austenite increases as quenching temperature increases. Quenching cracks occur in small pieces of steel when hardness in central portion is much greater than in periphery. Cracking is attributed to stress caused by difference in specific volumes of austenite and martensite. Paper read before Iron and Steel Inst.

Screw Stock. Heat Treatment of Screw Stock. A. A. Blue. Forging & Heat Treating, vol. 7, no. 5, May 1921, pp. 265–267, 7 figs. Prolonged treatment at high temperatures is necessary to refine llamilar structure caused by cold rolling. Greatest possibilities lie in case carbonizing.

STEEL MANUFACTURE

Chart. Development of Iron Ore Into Iron and Steel, S. C. Dickerhoff, Jr. Blast Furnace & Steel Plant, vol. 9, no. 5, May 1921, pp. 318–319, 1 fig. Chart illustrating processes of steel manufacture.

Converters. Calculation of the Additions in Small Converters (Berechnung der Zusätze beim Kleinkonverter), Bernhard Osaan. Giesserei-Zeitung, vol. 18, no. 5, Mar. 1, 1921, pp. 69–71, 1 fig. Method of determining manganese and silicon content in additions to steel.

Direct Process. Another Direct Process for Steel Making, Herbert Lang. Iron Age, vol. 107, no. 19, May 12, 1921, pp. 1237–1238. Mixture contained in retort and charged into reverberatory furnace. Steel produced in melting compartment. Method of Direct Steel Process Co. Inc.

STEEL MILLS

Czecho-Slovakia. The Steel Works of Czecho-Slovakia. Am. Mach., vol. 54, no. 19, May 12, 1921, pp. 826–829, 9 figs. Steel mills have melting capacity of 8000 tons per month. Electric furnaces are used.

Electric Drive. A New Balanced Sheet Mill Drive, Josef Hirschmann. Blast Furnace & Steel Plant, vol. 9, no. 5, May 1921, pp. 328–329, 1 fig. Drive consists of 25-hp. motor running at 750 r.p.m. direct-connected to speed reducing gear transmission by means of flexible coupling.

Handling Materials. Mechanical Handling of Steel Mill Material, C. F. Poppleton. Blast Furnaces & Steel Plant, vol. 9, no. 5, May 1921, pp. 291–298, 12 figs. Methods at Midland plant of Pittsburgh Crucible Steel Co.

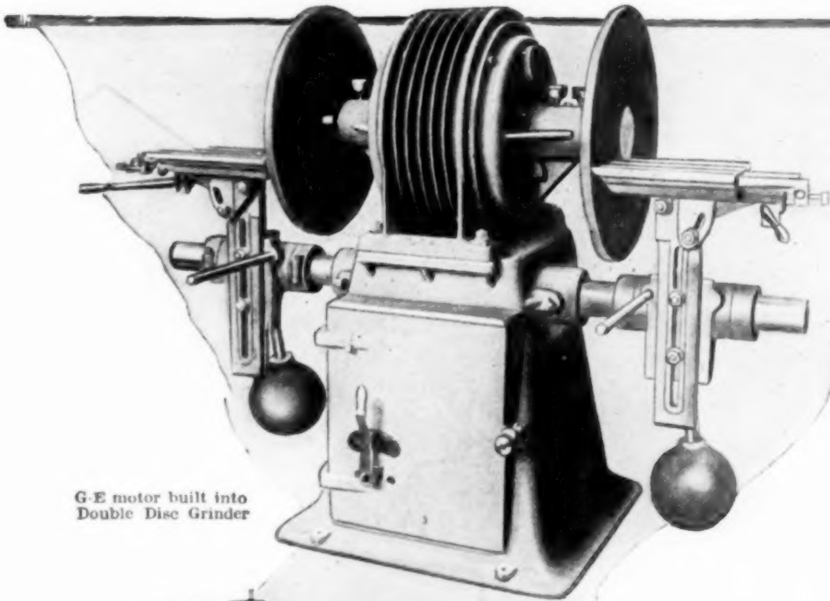
Lorraine. The Thyssen Works, Hagondange, F. Dahl. Iron & Coal Trades Rev., vol. 102, no. 2774, April 29, 1921, pp. 589–595, 10 figs. Description of steel works. Translated from Stahl und Eisen.

Russia. The Donetz Region of the Bolshevic Government—II, M. Ullrich. Blast Furnace & Steel Plant, vol. 9, no. 5, May 1921, pp. 314–316. Notes on iron and steel industry in Russia.

STOKERS

Underfeed. Development and Application of Underfeed Stoker, Edward Rahm, Jr. Proc. Engrs. Soc. of Western Pa., vol. 37, no. 1, Feb. 1921, pp. 21–52 and (discussion) pp. 53–68, 16 figs. History of developments in U. S.

Modern industry has no place for the old, inefficient methods of power transmission with their high power losses and frequent service interruptions



G-E motor built into
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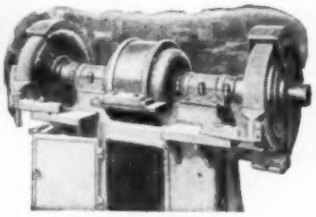
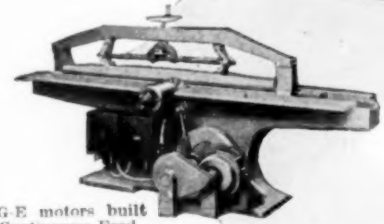
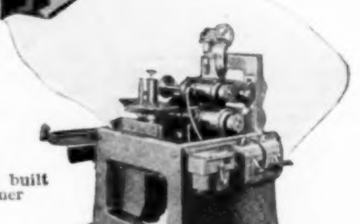


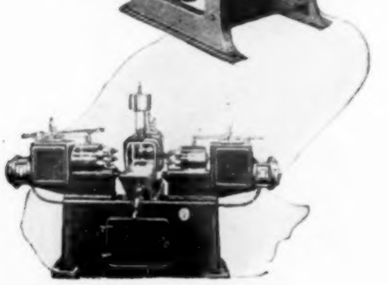
G-E motor built into
Safety Emery Wheel



Two G-E motors built
into Continuous Feed
Glue Jointer



Three G-E motors built
into Saw Tenoner



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ENGINEERING INDEX (Continued)

STRESSES

Buckling and Bending. Buckling and Bending (Knickung und Biegung), H. Ellerbeck. Zentralblatt der Bauverwaltung, vol. 41, no. 25, Mar. 26, 1921, 3 figs. Discussion of approximate formulas for buckling resistance and bending stress.

Determination with Polarized Light. The Determination of Stresses in Stressed Bodies with the Aid of Polarized Light (Die Bestimmung der Spannungen in beanspruchten Körpern mit Hilfe polarisierten Lichtes), H. Schulz. Betrieb, vol. 3, no. 14, Apr. 10, 1921, pp. 405–412, 12 figs. Discusses laws of propagation of light in anisotropic bodies and apparatus for observation of double refraction caused by stress. Examples of different cases of stressed bodies, such as influence of external pressure or tensile forces, irregularities of structure, and temperature influence.

Photoelastic Analysis. Photo-Elasticity for Engineers—V, E. G. Coker. Gen. Elec. Rev., vol. 24, no. 5, May 1921, pp. 455–466, 14 figs. Stress-strain properties of nitro-cellulose and law of its optical behavior.

SUBMARINES

Detection. The Nash Fish for Submarine Locating. Elec. Times, vol. 59, no. 1541, April 28, 1921, pp. 403–404, 2 figs. Measurements by rotating transmitters.

SUPERHEATERS

Design. Modern Practice with Steam Superheaters and Their Fields of Use, H. B. Oatley. Jl. Eng. Inst. of Canada, vol. 4, no. 5, May 1921, pp. 289–300, 17 figs. Notes on design of superheaters, including detailed study of types of installations, application and use, also comparative tables of performance with saturated and superheated steam.

Flue Tubes. The Manufacture of Flue Tube Superheaters. Engr., vol. 131, no. 3408, April 22, 1921, pp. 438–440, 10 figs. Procedure at works of Marine and Locomotive Superheaters, Westminster, England.

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TERMINALS, LOCOMOTIVE

Mallet Locomotives. Improving Terminals for Mallet Operation. Ry. Age, vol. 70, no. 18, May 6, 1921, pp. 1063–1068, 11 figs. Locomotive terminal of Norfolk & Western Railroad at Roanoke, Va.

Operation. Intensive Operation of Locomotive Terminals, L. G. Plant. Ry. Rev., vol. 68, no. 17, April 23, 1921, pp. 641–644, 2 figs. Urges standardization of terminal equipment and statistical control of terminal operation.

TERMINALS, MARINE

Mechanical Equipment. The Handling of Goods at the Port of Manchester Warehouses. Engineering, vol. 111, nos. 2888, and 2889, May 6, and 13, 1921, pp. 541–544, 23 figs., and 576–577, 12 figs., partly on suppl. plate. There are 44 distinct warehouses which can accommodate about 500,000 tons of perishable goods under cover, besides unlimited quantity in open storage. Methods of handling wool, material in bags, cotton, etc., are described. Cold stores with capacity of 1,000,000 cu. ft.

TERMINALS, RAILWAY

New York. An Automatic Terminal Railway for New York. Eng. & Contracting, vol. 55, no. 20, May 18, 1921, pp. 491–495. Plan of steam and electric yard in New Jersey for joint use of New Jersey railroads and automatic-electric system. Scheme developed by New York, New Jersey Port and Harbor Development Commission.

TESTING MACHINES

Bradley-Richards. A New Metal Testing Machine. Eng. Production, vol. 2, no. 29, April 21, 1921, pp. 512, 2 figs. Bradley-Richards hydraulic testing machine.

Brinell Hardness Testing. Modern Testing Machines (Neuere Prüfmaschinen), E. Irion. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 13, Mar. 26, 1921, pp. 315–320, 21 figs. Deals with hardness-testing machines. Notes on importance of the Brinell test and the Brinell testing machines of the Düsseldorf Machine Corp.; measuring devices; testing machines for large and heavy pieces; relation between degree of hardness and tensile strength degree of hardness with different loads. Recommendation for a standard ball with diameter of 6.35 mm.

Compression. 500-Ton Compression Testing Machine. Engineering, vol. 111, no. 2886, April 22, 1921, pp. 488–490, 5 figs. Installed in engineering department of British Nat. Physical Laboratory. Machine is intended for making compression tests on stone and concrete and embodies unique application of Amsler principle of load measurement.

TESTS AND TESTING

Brinell Hardness Testing. Ball Testing of Materials for Hardness, Brinell Test (Etude sur l'essai de dureté à la bille. Essai Brinell) R. Guillery. Revue de Métallurgie, vol. 18, no. 2, Feb. 1921, pp. 1–110, 12 figs. Researches on elimination of time influence Testing for hardness with ball receiving pressure by impact.

Impact. Tests Under Repeated Impact (Quelques Essais aux chocs répétés), Leon Guillet. Revue de Métallurgie, vol. 18, no. 2, Feb. 1921, pp. 96–100. It was established that rupture produced by repeated impact takes place by progressive fissuration.

TEXTILE MACHINERY

Machine Running Recorder. Machine Running Recorder. Engineering, vol. 111, no. 2889, May 13, 1921, pp. 580–582, 9 figs. Machines constructed for controlling operation of textile machines. Each machine is connected with instrument in such a way that an electric circuit is completed when machine stops and blank line is started on record sheet.

TEXTILES

Microscopy. The Microscopy of Textiles, F. J. Hoxie. Textile World, vol. 59, no. 16, April 16, 1921, pp. 59 and 61, 3 figs. Recommonds coöperative study for needed development. Paper read before Textile Division, Am. Soc.Mech. Engrs.

Winding. The Art of Winding, George W. Foster. Textile World, vol. 59, no. 16, April 16, 1921, pp. 51 & 61. Its relation to production, cost and quality in textile industry. Paper read before Textile Division, Am.Soc.Mech.Engrs.

TIRES, RUBBER

Pneumatic. Design and Manufacture of Pneumatic Motor Tires, Colin Macbeth. Practical Engr., vol. 63, no. 1781, April 14, 1921, pp. 228–232, 12 figs. Outline of manufacturing systems. Paper read before Instn. Automobile Engrs.

Truck, Pneumatic. Use of Pneumatics Limited on Trucks of More Than $3\frac{1}{2}$-Ton Capacity. Automotive Industries, vol. 44, no. 18, May 5, 1921, pp. 960–961. Opinions expressed by truck and tire builders in reply to questionnaire.

TRACTORS

Caterpillar. Caterpillar Farm Tractors (Raupenschlepper für landwirtschaftliche Zwecke). Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 14, Apr. 2, 1921, p. 348, 1 fig. New Bussing tractor with slow-speed engine of 55 hp. and capable of traveling up to 6 km. per hr.

Gear for Snow Riding. Cars for Mountains (Chars de montagne), L. Périssé. Nature (Paris), no. 2451, Mar. 26, 1921, pp. 193–195, 5 figs. Typical tractors with running gear adopted for travel on snow-covered road.

Tests. Data on Illinois Tractors. Jl. Soc. Automotive Engrs., vol. 8, no. 5, May 1921, pp. 487–488. Survey made by Division of Farm Mechanics, University of Illinois, comprising records kept by farmers on 68 tractors.

Nebraska Tractor Tests, Oscar W. Sjogren. Jl. Soc. Automotive Engrs., vol. 8, no. 5, May 1921, pp. 391–395, 6 figs. Nebraska tractor law provides that stock tractor of each model and type sold in State shall be tested and passed upon by board of three engineers under State University management.

TUBES

Brass. Internal Stresses in Brass Tubes, H. N. Vaudrey and W. E. Ballard. Metal Industry (Lond.), vol. 18, no. 15, April 15, 1921, pp. 290–292, 6 figs. Experimental investigation of circular tubes containing 70 per cent copper.

Design. Design of a Tube Supporting a High Internal Pressure (Calcul d'un tube supportant une forte pression intérieur), E. Sinard. Arts et Métiers, vol. 1, no. 1, Oct. 1920, pp. 18–20, 8 figs. Formulas for computing stresses.

Seamless. Finishing Process for Seamless Tubes. Iron Age, vol. 107, no. 17, April 28, 1921, pp. 1114–1118, 11 figs. Details of Pilgrim-step finishing process. Working hollow ingot on mandrel, between rolls, in such manner that at each revolution of rolls small portion of ingot is rolled to tube, is principle. Translated from Stahl und Eisen.

On the Manufacture of Seamless Tubes—III, Karl Gruber. Blast Furnace & Steel Plant, vol. 9, no. 5, May 1921, pp. 320–323, 9 figs. Processes of rolling seamless tube in Germany with special consideration of Mannesmann oblique rolling process. Translated from Stahl und Eisen.

TUNNELS

Vehicular. Shield vs. Trench Method for Hudson Vehicle Tubes, C. M. Holland. Eng. News-Rec., vol. 86, no. 18, May 5, 1921, pp. 764–766. Why shield method has been selected in preference to trench method for construction of Hudson River vehicular tunnels between New York and New Jersey.

V

VACUUM

Methods of Production. Methods for the Production and Measurement of High Vacua—VIII, Saul Dushman. Gen. Elec. Rev., vol. 24, no. 5, May 1921, pp. 436–443, 2 figs. Physico-chemical methods.

VALUATION

Railways. An Analysis of the Current Valuation Report on the Kansas City Southern Properties, Samuel W. Moore. Eng. News-Rec., vol. 86, no. 19, May 12, 1921, pp. 818–821. Status of investigation of date. Present announcement of Interstate Commerce Commission includes single sums as "value" but no statement of method. Land acquisition costs apparently disallowed.

VENTILATION

Office Building. Ventilation of the Home Office Building of the Travelers Insurance Company, Hartford, Conn. Am. Architect, vol. 119, no. 2364, April 13, 1921, pp. 459–462, 4 figs. System is composed of two parts, (1) blower section which includes distributing apparatus, and (2) exhaust section which consists of apparatus by means of which used or vitiated air is removed from building. In each of these sections air is propelled through metal ducts and chambers by fans operated by individual electric motors.

VOCATIONAL EDUCATION

Disabled Soldiers. Making Mining Engineers from Disabled Soldiers, W. A. Clark. Eng. & Min. Jl., vol. 111, no. 17, April 23, 1921, pp. 706–708, 3 figs. Project of Federal Board of Vocational Education, Washington, D. C.

The Re-Education of the Disabled, J. Manclark Hollis. Jl. Royal Soc. of Arts, vol. 69, no. 3568, April 8, 1921, pp. 318–324, 5 figs. Work being carried out by Village Centers Council, England.

VOCATIONAL TRAINING

Disabled Workmen. Industrial Rehabilitation—General Administration and Case Procedure. Federal Board for Vocational Education, Bul. no. 64, Mar. 1921, 52 pp. Rehabilitation is considered from point of view of State administrations.

Pennsylvania Bureau of Rehabilitation. Bureau of Rehabilitation Pennsylvania Department of Labor and Industry Report of Activities to January 1, 1921, Bul. Dept. of Labor & Industry, vol. 8, no. 2, Jan. 1, 1921, 30 pp.

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WAGES

Changes in Industry. Wage Changes in Industry. Nat. Indus. Conference Board, no. 35, Mar. 1921, 52 pp. Survey of wage changes in major manufacturing industries in U. S. from Sept. 1914 to end of 1920.

WATER POWER

Argentina. Hydroelectric Power in Argentina, Leonard Matters. Sci. Am., vol. 124, no. 17, April 23, 1921, pp. 330 and 340, 2 figs. Scheme for generating 125,000 kw. from Eguazu Falls.

Japan. Regulations Governing Development of Water Power in Japan. Elec. World, vol. 77, no. 20, May 14, 1921, pp. 1101–1104, 3 figs. State governors have power to alter designs and rescind concessions. Basis of calculations required. Electric companies have right of eminent domain.

WELDING

Steel. The Welding of Steel, H. Brearley. Engineering, vol. 111, no. 2888, May 6, 1921, pp. 551–554, 12 figs. Welding of steel in relation to occurrence of pipe, blow-holes and segregates in ingots. (Abstract). Paper read before Iron & Steel Inst.

[See also AUTOGENOUS WELDING; ELECTRIC WELDING; ELECTRIC WELDING, ARC, OXY-ACETYLENE WELDING; RAILWAY REPAIR SHOPS, Electric Welding.]

WELDS

Heat Treatment. Effect of Heat Treatment on Metal Arc Welds, James W. Owens, J. H. Ramage and J. A. Watts. Ry. Elec. Engr., vol. 12, no. 5, May 1921, pp. 189–193, 10 figs. Metallographic studies made at U. S. Navy Yard, Norfolk, Va.

Testing. The Desirability of Standardization in the Testing of Welds, F. M. Farmer. Jl. Instn. Mech. Engrs., no. 3, April 1921, pp. 225–240, 5 figs. Standards for evaluating welds are suggested and certain standard procedures are proposed for various mechanical tests.

WELFARE WORK

Restaurants. The Factory Restaurant as a Service Nucleus, Sanford DeHart. Indus. Management, vol. 41, no. 9, May 1, 1921, pp. 338–340. Experience of R. K. LeBlond Machine Tool Co., Cincinnati, O.

WIND TUNNELS

Design. National Advisory Committee's 5-ft. Wind Tunnel, F. H. Norton. Jl. Soc. Automotive Engrs., vol. 8, no. 5, May 1921, pp. 489–495, 16 figs. Tunnel is of venturi type with continuous throat of circular section and there is airtight experimental chamber built about working section in order that small holes may be opened into tunnel while it is running without disturbing airflow.

Intake Bell. Experiments on the Design of Intake Bell for a Wind Tunnel. U. S. War Dept., Air Service Information Circular, vol. 3, no. 217, April 30, 1921, 8 pp. 5 figs. Object was to investigate effect of intake bell on smoothness of flow in wind tunnel. Conclusion reached was that Grimes type intake bell gives best velocity distribution.

McCook Field. Description of the McCook Field Wind Tunnel. U. S. War Dept., Air Service Information Circular, vol. 2, no. 196, April 30, 1921, 8 pp. 6 figs. McCook field wind tunnel is used for high-speed investigations of instruments, aerofoils, etc. Speeds up to 525 m.p.h. are attained.

WOMEN WORKERS

Two-Shift Systems. The Two-Shift System for English Working Women. Monthly Labor Rev., vol. 12, no. 4, April 1921, pp. 92–95. Approval by parliament of bill permitting under certain conditions employment of women in workshops at any time between 6 A.M. and 10 P.M. in shifts averaging not more than 8 hr. for each shift.

WOOD PRESERVATION

Treatment. Modern Wood Impregnation Methods, Friedrich Moll. Eng. Progress, vol. 2, no. 3, Mar. 1921, pp. 55–56, 4 figs. Rüping economic process. Part of oil is forced out again.